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ARMY R,D&A

Vol. 26 No. 5 SEPTEMBER-OCTOBER 1985

OFFICIAL MAGAZINE OF THE RDA COMMUNITY, established 1959

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ABOUT THE COVER:

The front cover relates to our lead articles on program management. The back cover, which shows steel being arc sprayed onto a surface at the U.S. Army Construction Engineering Research Laboratory, is associated with a feature article on the Army's Research and Development Achievement Awards. Cover designed by Daniel Jeffrey Marks, AMC Graphics Section.

FEATURES

DEPARTMENTS

DISTRIBUTION is based on requirements submitted on DA Form 12-5. Army agency requirements must be mailed to the U.S. Army AG Publications Center, 2800 Eastern Boulevard, Baltimore, MD 21220.

Distribution on an individual basis is restricted to active and reserve officers who hold initial or additional specialties of R&D (51), Nuclear Energy (52), or Procurement (97), or an additional skill identifier of 6T.

CHANGE OF ADDRESS. Individual addresses are provided by Officer Military Personnel Center, Alexandria, VA, and the USARPC, St. Louis, MO. Where active officer addresses are incorrect, individuals should contact their respective officer personnel office to ensure forwarding of correct address. Reservists should contact USARPC, ATTN: AGUZ-OEPMD, St. Louis, MO 63132.

OTHER GOVERNMENT AGENCIES requirements should be submitted directly to U.S. Army Materiel Command, ATTN: AMCDE-XM, 5001 Eisenhower Ave., Alexandria, VA 22333.

FOR SALE BY the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

(USPS-584-330)

Army R,D&A (ISSN 0162-7082) (Vol. 26, No. 5) is an official Army periodical published bimonthly by HQ U.S. Army Materiel Command (AMC), Alexandria, VA 22333, under sponsorship of the Assistant Secretary of the Army (Research, Development & Acquisition); the Deputy Chief of Staff for Research, Development and Acquisition, Department of the Army; and the Commander, AMC.

Purpose: To provide a channel of communication among all members of the Army RD&A community and other government RD&A agencies; to promote the interchange of ideas and further the understanding of the RD&A process and RD&A management philosophy.

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Submission of Material: All articles submitted for publication must be channeled through the technical liaison or Public Affairs Officer at installation or command level.

Bylined Articles: Primary responsibility for opinions of bylined authors rests with them; their views do not necessarily reflect official policy or position of Department of the Army.

Second class official mail postage paid by the United States Army at Alexandria, VA, and at additional mailing office. Forward copies per Domestic Mail Manual part 159.225. Use of funds for printing this publication has been approved by the Secretary of the Army on 19 February 1985 in accordance with the provisions of AR 310-1. POSTMASTER: Send address changes to *Army RD&A Magazine*, 5001 Eisenhower Avenue, Alexandria, VA 22333.

D 101.52/3: 26/5

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The Materiel Acquisition Management Program

By MAJ Richard D. Nidel

MAM Program Initiation

The Materiel Acquisition Management (MAM) Program was initiated in November 1983. MAM subsumed its predecessor, the Project Manager Development Program (PMDP), and has the objective of developing officers to serve in all senior materiel acquisition management positions, to include project management.

The Army Materiel Command (AMC), as the program's proponent, has identified over 2,000 Army officer positions requiring materiel acquisition skills. These positions are located throughout the Army Materiel Command and its subordinate materiel readiness commands, the DA Staff, the Operational Test and Evaluation Agency, the Training and Doctrine Command, the Defense Logistics Agency and other key Army organizations involved in the materiel acquisition process. The MAM Program, like the PMDP, uses the additional skill identifier (ASI) "6T" to identify both the MAM positions and the program members.

The U.S. Army Military Personnel Center (MILPERCEN) administers the MAM Program for the Army through its Career Programs Branch within the Directorate of Officer Personnel Management.

Entry into MAM

The MAM Program is described in detail in Chapter 101, DA Pamphlet 600-3, which is contained in the "Officer Ranks Personnel Update." Entrance into the program is through a MILPERCEN board selection process. Officers must apply to or be nominated through their career management division to the MAM Program Office within MILPERCEN. Basic qualifications for entry include: officer in OPMD branch; science, engineering, or business management degree is highly desirable; hold an acquisition specialty (SC 27, 45, 49, 51, 52, 53, 71, 72, 73, 74, 75, 91, 92, or 97); completed branch qualification, to include Officer Advanced Course; have at least five and a half years of active federal commissioned service; have at least six years of service remaining; and have demonstrated proficiency and promotion potential.

The above qualifications are the minimum desired of officers at the grade of captain. Ideally, more senior officers will have had previous materiel acquisition management assignment or military schooling experience before applying for entry into the program.

The MAM Program is requirements driven. The grade and specialty mix of the Army's validated materiel acquisition management positions directly influence the required size and mix of the MAM officer inventory. Thus, as Army requirements change, so too can the overall requirements for officers in the MAM Program.

MILPERCEN convenes an internal MAM selection board, as required, to review all applications and nominations received since the previous board. Current experience requires the convening of the board three to four times annually.

The board is composed of MILPERCEN professional development officers and career program managers. Each file is reviewed by a minimum of three board members. Acceptance by the selection board results in the award of the ASI 6T. MILPERCEN will make the appropriate entry into the Officer Master File. No further personnel action by either the officer or the military personnel office is required.

MAM Assignments

Once an officer enters the program he or she should submit a new Officer Assignment Preference Statement, DA FORM 483, to the appropriate career management branch within MILPERCEN. All future assignments, including MAM positions, will continue to be made by the Officer's career management division branch or functional area assignment officer.

MAM Officer Positions (As of 15 Oct 84)

Grade	Number
COL	285
LTC	626
MAJ	618
CPT	546
	2,075

Figure 1.

MAM Requirements Positions By Organization

DOD	85
DA	117
TRADOC	559
AMC	1,052
OTHER	262
	2,075

Figure 2.

Tips From the MAM Career Program Manager

- Keep your Officer Record Brief (ORB) up to date. Use clear descriptive words in the duty titles and avoid the use of common abbreviations and acronyms.

- Graduates of the MAM Course should have the entry "Materiel Acquisition" in Section VI—Military Education on the ORB.

- Graduates of the Program Management Course should have the entry "DEF PROG MGT CRSE" in Section VI of the ORB. MILPERCEN automatically generates this entry upon course graduation, but officers are encouraged to verify.

- ASI 6T is only awarded by MILPERCEN board selection. Assignment to positions coded 6T or attendance at one of the appropriate schools does not authorize the award of the ASI.

- If appropriate to the duty position, include ASI 6T in Part III, block b (SSI/MOS) of the Officer Efficiency Report, DA Form 67-8.

- Review your assignment history (Section IX) on the ORB to ensure that the duty MOS (DMOS) is accurately reflected.

- In accordance with AR 350-100, attendance at the Program Management Course incurs an active duty service obligation of three for one, counted in days. This obligation amounts to 59 weeks.

The MAM career program manager, while not directly involved in assignments, serves as a consultant on MAM assignments to both the individual officer and to the assignment officer. Additionally, assignment actions to MAM positions are coordinated between the assignment officer and the MAM Program Office.

The duty positions that have been validated to require MAM skills, and which are coded with ASI 6T, are predominately in CONUS. Figures 1 and 2 show the relative distribution of these positions by grade and organization. Because some of the MAM qualifying specialties are of low density, choice of assignment area in these specialties is somewhat limited. It should also be noted that, due to the changing requirements of an organization and the volatility of Tables of Distribution and Allowances (TDA) position coding, the identification of all positions requiring MAM officers is a very inexact science. As a result, many other materiel acquisition management assignments are available, even though the position may not be coded ASI 6T. Knowledge of the organization, the environment, or the specific duties of a position may result in the conclusion that a given assignment is appropriate, although on the surface the position coding may not have so indicated.

MAM Schooling

As stated in DA Pamphlet 600-3, the program's goal is to develop selected officers as materiel acquisition managers through military schooling and MAM assignments. The appropriate military schooling includes the nine week Materiel Acquisition Management Course at the Army's Logistic Management Center at Fort Lee, VA, and the Program Management Course at the Defense Systems Management College at Fort Belvoir, VA. Ideally, program members will attend the MAM Course as a captain and the Program Management Course as a major. While the MAM Course is also attended by officers holding SC 51 and non-program members being assigned to MAM positions, all officers attending the Program Management Course must be in the MAM Program.

The Army's Advanced Civil Schooling Program supports MAM officer educational requirements, particularly in science, enginering, business management, industrial management, materiel acquisition management and the procurement and contracting disciplines. In addition, cooperative degree programs through the Command and General Staff College and the Logistics Executive Development Course are available. Officers interested in advanced civil schooling opportunities should contact their branch professional development officer.

MAM Certification

The MAM Program concept includes a certification procedure, once an officer has been selected for promotion to lieutenant colonel. Certification requirements include completion of the MAM and Program Management Courses and satisfactory performance in at least two materiel acquisition management assignments, outlined in detail in DA Pamphlet 600-3.

The first MAM certification board was recently held with the combined purpose to review PMDP Program members for transition to MAM and to evaluate eligible officers against the certification criteria. Those officers who could not be directly transitioned into MAM were given the opportunity to request a specialty change, if appropriate.

The goal of the MAM Program, at maturity, is to remove ASI 6T from the records of officers who do not meet the certification requirements. However, as the program is relatively new and the officer inventory is not yet fully developed, officers not meeting the certification requirements will be continued in the program. These officers will be reviewed by the annual MAM Certification Board. The next board is expected to be held in early 1986 to review the lieutenant colonel selectees from the 1984 and 1985 promotion lists, as well as those officers previously not certifiable. Certification requirements will become more and more stringent as the program evolves.

MAM certification will be annotated on the Officer Record Brief (ORB) in section X of the remarks block. A certificate will be sent by MILPERCEN to each certified MAM officer. Additionally, a copy of the certificate will be entered into the Performance Fiche of the Official Military Personnel File.

The MAM Certification Boards will be composed of MAM program members who have served in materiel acquisition positions. The board president will be a colonel or promotable lieutenant colonel. Board members will have available the Officer Record Brief and the Performance Fiche to evaluate each officer's file.

The verification of military schooling requirements will be made by a review of Section VI of the ORB and the Aca-

demic Efficiency Reports showing course completion. Verification of successful completion of materiel acquisition assignments is generally done in the following manner:

MAM duty positions held should reflect the ASI 6T in the duty military occupational specialty (DMOS) column of Section IX-Assignment History. If appropriately coded, the board member then reviews the detailed job description and performance evaluation contained in the Officer Efficiency Report. The board member will then reach a determination as to the appropriateness of the assignment and the officer's demonstrated manner of performance.

It should be noted that the ASI 6T code in the TDA may not always reflect on the ORB due to a variety of administrative reasons. To resolve this problem, when a certification board member reviews a file, close attention is paid to every assignment that is coded with one of the appropriate acquisition specialties, even though the ASI 6T may not be indicated. After careful review of the duty description in the Officer Efficiency Report, the board member determines the appropriateness of the MAM assignment in the same manner as above.

Product and Project Management

There are currently approximately 15 chartered product manager positions that have been identified by materiel developers. All MAM Program lieutenant colonels and promotable majors are eligible for selection as product managers. In the past, MILPERCEN convened the Product Manager Selection Board on an as required basis. FY 86/87 product managers will be centrally selected through the DA secretariat in conjunction with the 0-5 command boards and announced concurrently with the lieutenant colonel command list in mid-calendar year 1986.

MAM Program colonels and promotable lieutenant colonels are also eligible for selection to one of the approximately 60 Army project manager positions. In the past, selection was made for PM vacancies projected on a calendar year basis. Beginning with the 1986 Project Manager Board, future selections will be made on a fiscal year basis in conjunction with the colonel command selection process. In addition, project manager designees who are not graduates of the Program Management Course will be required to successfully complete it before assuming duties as a PM.

Key Initiatives

In addition to those initiatives mentioned above regarding certification and product/project management, a number of other initiatives have recently been taken:

- This year's 0-5 and 0-6 promotion boards were provided with a single page summary sheet to familiarize board members with each Officer Personnel Management System specialty. Although not a specialty program, an ASI 6T summary sheet was provided to these boards.

- MILPERCEN has initiated internal policies to improve the visibility of the ASI 6T in the assignment process. This has resulted in an increased awareness of the professional development requirements of program members.

- The Officer Personnel Management Directorate recognizes that for program members, MAM assignments are of the same priority as other valid Army requirements.

- Each MILPERCEN career management division has established a functional area assignments branch. Control of functional area assignments and the career management of officers, sequentially tracking in functional areas, will be conducted by these branches.

Current Program Status

The MAM Program currently has 1,900 officers in the grades of captain through colonel. While the program needs more officers at all grades, the most critical demand is at the grade of captain. Officers possessing one of the qualifying specialties are encouraged to consider application to the Materiel Acquisition Management Program. Any branch qualified captain who is interested in the program, but has not yet been awarded an additional specialty or functional area, may request early designation through his/her career management branch within MILPERCEN.

For further information, please contact your MILPERCEN professional development officer or the MAM career program manager at AUTOVON 221-0417.

MAJ RICHARD D. NIDEL is the U.S. Army Military Personnel Center career programs manager for specialty codes 51/97 and ASI 6T, Materiel Acquisition Management. He received a B.S. degree in chemistry and was commisssioned in the Ordnance Corps (ROTC distinguished military graduate) from Duquesne University in 1970. He has an M.S. degree in chemical engineering from the University of Virginia and has completed the Army Command and General Staff College and the Defense Systems Management College's Program Management Course.

NOTICE

- The pictorial listing of Army Materiel Command program managers will be published in a later issue of Army RD&A magazine, instead of this issue as previously announced.

- A reminder to active and reserve officers in the 51, 52, 97 and 6T specialties: Since we have switched to using your address as listed in your Officer Record Brief, it is important that you keep your records updated. A number of requests for change of address have been mailed to us, but we do not have the capability to make those requested changes. Your address comes to us in a computer printout from MILPERCEN. If you have changed your address recently, please change your ORB so the magazine can reach you at the proper address.

Program Management Incentives

By MAJ Roland E. Sasser

The U.S. Army is currently in the midst of the largest modernization effort ever undertaken in war or peace. According to the Army chief of staff, some 400 new systems will be put into the inventory before the year 2000. At the base of that modernization process is the program manager (PM) who manages major systems from their inception to the time the program or equipment reaches the field. That process even continues on some projects after the item is fielded. For example the M60 Main Battle Tank still has a PM office even though it was fielded in the late 1960s.

Most Army PMs usually work in some element of the Army Materiel Command. Currently, approximately six percent of the officer corps manages 37 percent of the Army's budget. There are many more personnel, military and civilian, who support these programs directly or indirectly through a matrix management concept.

The Army PM probably has one of the most pressure filled jobs in the Army. He may deal with Congress, the secretary of defense, the Army secretary, the Army chief of staff, and other intermediate levels at any given time on acquisition matters involving hundreds of millions of dollars. He may be pressed for quick momentous decisions that can affect his program and even the entire Army-in-the-field. He may brief his program eight or nine times a day to varying levels of the Army and then be required to fly all night to reach a critical event or another briefing.

The PM is continually asked to justify every penny for his program and to develop numerous "what if" scenarios for each Congressional budget cycle. He is prone to television show exposure and to probing by the news media whenever his program might be in trouble.

By this time you may be asking why anybody rational would want this job. That is the essence of what I want to explore. Why does the Army need skilled and motivated acquisition managers? What has the Army done in the past to attract these officers? What are some of the incentives and disincentives that exist now for an officer to enter this field? (Civilians are clearly recognized as extremely valuable links in the acquisition process but due to time and length constraints, I will explore only the military aspect.)

In order to draw qualified and motivated people, the acquisition management task must be looked upon as an attractive job with some real incentives. My contention is that currently the incentives are weak at best and that there are some very real disincentives.

The Need for Good Managers

First, let's take a look at why the Army needs skilled and motivated acquisition managers. The issue of obtaining qualified and motivated people to work in program management was explored as a part of a study by the Defense Systems Management College on successful DOD program management offices. In general, the report looked at successful attributes of these programs trying to develop some useful guidance for future PMs. One of the questions asked of the participants was what made their program stand out above others. An article resulting from the study stated in part, ". . .Reasons for success cited most often are first, good people. . . Good people are an absolute must . . . The service PMs try to name request people after careful, deliberate evaluation of their capabilities and background. . ."

Given this need for good people in the PM arena, what do the services do to provide incentives for participation? First, it should not be said that DOD has ignored this valid need. DOD Directive 5000.23, dated Nov. 26, 1974, states ". . . Career opportunities shall be established to attract, develop, retain and reward outstanding military officers and civilian employees required as program managers, or as their principal deputies/assistants. . ."

But, has the Army really done enough in offering incentives to reward its military personnel or at least to undermine the disincentives? A report by the Defense Audit Agency done in 1983 stated ". . . The Army's programs for military officers partially implemented the Directive (5000.23). . . " It should be noted in fairness that the Office of the Under Secretary of Defense recommended that the report be "reconsidered" due to its limited scope.

The Audit Agency inspector general's opinion was that after eight years, the Army still had not completed the task to create the environment directed by DOD which would attract, develop, retain and reward Army military or civilian PMs. Although this should not be considered a wholesale condemnation of what the Army has done in the past, it does point out rather clearly that there is room for improvement.

Past Programs

To explore the current position of the Army's program to attract and retain acquisition managers and how we got there, requires a look at past programs. The Army's system of developing systems acquisition personnel has been dovetailed onto its Officer Personnel Management System (OPMS). OPMS, initiated in the early 1970s, required an officer to develop two specialties rather than the previously required one. This allowed an officer to expand his experience base and was considered positive to the acquisition manager. But it was quickly recognized in the mid-1970s that with the increased emphasis on systems acquisition and the sheer volume of systems being fielded, that the acquisition officer still was not managed into the appropriate jobs. Those officers astute and lucky enough to influence their assignments into the acquisition arena had some success but most simply followed their basic branch career pattern.

In 1975, the Army initiated the Program Management Development Program (PMDP) because according to the Defense Audit Agency report ". . . The Army recognized that the OPMS concept failed to produce trained systems acquisition program managers. . ." In this program, the officers' career patterns and assignments were supposedly watched closely to guide them into acquisition assignments. The assignment officers of each branch were to coordinate with the PMDP Office before any assignment of an officer with a 6T identifier (PM) attached to his specialty code.

In late 1983, The PMDP was changed to the Materiel Acquisition Management (MAM) Program due to some of the same shortcomings of the basic OPMS concept. The goals of this program were basically the same as PMDP but this time sought to achieve more training and more assignments in the acquisition field. The new program also required, for the first time, certification for those officers who were to be selected as program managers.

Incentives

The above description gives us a feel for what has been done in the past and the current program for attracting acquisition personnel. Now let's turn our attention to how the prospective officer might look at this career field. What does he see as incentives and what are the disincentives?

The first incentive that many PMs and those working in PM offices would list is that job satisfaction and challenge are equal to or better than most jobs in the Army. In few other jobs does an officer have the opportunity to work in so many disciplines and combine the management and leadership practices he has been taught throughout his career. Those same items make the job challenging for even the best of officers.

Second, many officers would probably list as positive the aspect of visibility of himself to others and visibility of others by himself. That bears some explanation. Anyone's basic need is to be recognized by others for what is being accomplished. In program management you are visible to virtually everyone Army-wide who might have reason to come in contact with your system. If you do the job well, you will be recognized by subordinates, peers, and superiors for individually having a hand in the success. Program management is also rather unique in that you are allowed to see firsthand who the real "winners" are. This usually allows you some rational career decisions in the future of who to work with or for.

Third, program management is certainly a useful job skill when the officer decides to leave the service. Civilian industry actively recruits military program managers at a pay scale acceptable by most standards.

Fourth, being a PM is career enhancing. But let me be quick to point out that for the acquisition officer who only works in the program and never becomes the actual PM, it may not be career enhancing. This caveat fits most of the acquisition officers who work in programs. There are more than 70 actual PM positions but over 2,000 slots in acquisition management.

Disincentives

Now let's look at some of the disincentives. Most officers in acquisition management would probably state that their promotion potential is below that of their peers who are in the Army-in-the-field commanding units. There are no surveys which can substantiate these feelings. The only gauge that I personally have is the general attitude of assignment and professional development officers and what senior officers are usually willing to say off the record. Most are of the opinion that program management is not the equivalent of command at any level, even though this is actually directed by the DODD 5000.23.

Being the actual PM is not considered a damaging career job, but it still does not have the "luster" of a command job. Those who only work in the PM office may well be at peril in career progression if they do not regularly rotate into the Army-in-the-field jobs.

A second disincentive is the difficult environment in which the acquisition officer must work. High stress due to the circumstances already mentioned is a real and potential health hazard. Other service jobs have similar stress but few have the awesome responsibility, at least in peacetime, as does the PM. Another aspect of environment is location. The choices of location for Army PMs are mostly in the Northeast or the North Central United States. Another environmental aspect is one of longevity in the job. Many in this field find that they are averaging more moves than their peers. They also find that they spend more time away from their family on government business than their peers do.

A third disincentive is the lack of money commensurate with the responsibility. I don't mean to say that an acquisition officer should receive incentive pay above that of his fellow officers. I only want to point out the large disparity between the acquisition manager and his direct civilian counterpart who might be receiving two or three times his salary.

Fourth is the career aspect of being out of the mainstream during the early competitive years as a junior officer. To be in the arena of acquisition management during these years instead of in the Army-in- the-field, is considered by many as "getting over" or not paying your dues. The OPMS system validates this concept in that it has not yet developed a specialty for the acquisition manager. Additionally, precedence is still given to branch assignments over acquisition assignments.

A fifth disincentive is the lack of education for the job. The Army is doing a better job in this area since the MAM Program requires a certain level of education before certification. However, the Defense Audit Agency report referenced above stated that only 404 officers of the 1,404 in the PMDP had attended the 20-week Program Management Course at the Defense Systems Management College.

What Can Be Done?

Given all of the above incentives and disincentives, what can the Army do in the future that will encourage officers into acquisition management? Most items I would suggest have been hinted at above, but let me emphasize them in conclusion.

One, the career image of program management must be enhanced by our senior officers and the ensuing promotion and selection boards. This means a change in attitude and even some regulatory changes to insure these officers receive an even chance for promotions and career enhancing jobs.

Two, we must develop young officers by moving them into acquisition-type jobs every second or third assignment. Considering a 20-year career, that means three or more assignments in acquisition jobs.

Three, we must educate these officers in civilian and military schools to be able to manage multimillion dollar programs. An added bonus here would be to continue and even expand the Training With Industry Program.

Finally, maybe it is time for the Army to develop a distinct field for the acquisition manager. The Air Force has proven the concept. The Army has approved the concept for the Aviation Branch. The idea that an Army officer does everything well may be invalid in this age of high technology and specialization. It is recognized by most that some officers are definitely better at management than at leadership. Professional acquisition managers are needed now.

MAJ ROLAND E. SASSER is assigned as the maintenance officer with the 182nd Division Materiel Management Center, 82nd Airborne Division, Fort Bragg, NC. He authored the preceding article while he was a student at the Defense Systems Management College.

PM Office Update

MAJ Sasser's thought-provoking article deserves some added comments from the HQ, AMC corporate level. The well written article calls for the Army to improve the project manager (PM) and PM staff environment. We believe we are doing this and will continue to do so. For instance, colonel-level PMs are now centrally selected by a DA board that meets during the same period as command boards. Board results for PM selection are announced concurrent with and in the same manner as colonel-command selection. Soon we will board select lieutenant colonel product managers and announce selections in the same manner.

As MAJ Sasser correctly points out, good training and experience are essential if a PM is to be equipped to do his job. All PMs, both product managers and project managers, are required to attend the 20-week Program Management Course (PMC) at the Defense Systems Management College (DSMC). Other PM office personnel are regularly scheduled into the PMC and other courses taught at the DSMC. As the proponent for the Materiel Acquisition Management program, AMC works with the Military Personnel Center to manage individuals, by name, throughout the PM program from captain to general officer. Specialized schooling and assignments will be programmed into each officer's career. At HQ, AMC we have expanded, and will continue to expand, the responsibilities of the Office of Project Management so that all PM personnel have a "home" at the headquarters to direct, encourage and enhance the careers of aspiring PMs.

The Army recognizes the importance of project management. The most recent brigadier general board selected seven serving or former PMs for promotion. More than 30 active duty general officers were former PMs during their careers.

MAJ Sasser's article talks to the need for PMs, good PMs. He's absolutely right. We need them. The soldier needs quality, affordable, timely equipment.

LTC William R. Holmes, Chief, Office of Project Management HQ, Army Materiel Command

An Improved M1 Abrams main battle tank is shown during tests on the Munson Test Course, APG, MD. The rear of the turret shows the new mounting brackets for a newly designed stowage rack.

CSTA Works on M1 Tank Improvements

Engineers at the Army's Combat Systems Test Activity (CSTA), Aberdeen Proving Ground, MD, are working on some key improvements to the M1 Tank. According to Ted Wheeler, acting chief of CSTA's Tracked Vehicle Branch, and Michael P. Dillen, senior test director for the M1 tank improvement program, a variety of changes are being incorporated into the combat vehicle's design.

"One of our major concerns," Wheeler said, "involves improving the life span of the tank's tracks for a reduction in field operating and support costs. The old T156 tracks were good for about 600 to 1,100 miles, depending on terrain and weather conditions, before the rubber pads wore out. A prototype design (XT 158H) track was tested and determined to offer potential for reducing life cycle cost. This track is currently being subjected to additional improvements for both the track pin and bushing area prior to the future qualification test. Projected future improvements to the XT 158H tracks include more resilient, two-bolt center guide horns and new spilt-end connectors for the tracks."

Wheeler said the new track design is slated to compete against a West German design, the Diehl D570N, which is similar to the tracks used on the West German Leopard main battle tank.

The improved M1 features a lower final drive ratio. The earlier M1s had a 4.30-1 final drive ratio while the improved M1 has a ratio of 4.67-to-1. The improved M1 retains the same rapid acceleration from 0-20 mph. However, its top speed has been reduced to 41.5 mph from 45 mph.

Dillen said, "We've also made the transmission stronger with improvements to the transmission clutch design. The suspension also has been redesigned to accommodate the modifications which have increased the tank's weight.

"We've re-indexed the torsion bars to maintain the same ground clearance as on the earlier M1s, increased the damping rate of the shock absorbers, and we've strengthened the compensating idler arm."

Stowage on the tank also has been improved through addition of a rear stowage bustle on the back of the turret. The stowage bustle is detachable to facilitate easy repair and transportation of the tank, Wheeler said.

"We feel the change we're testing on the M1 will greatly enhance its survivability, durability and reliability," Wheeler said. "The tank will be easier to maintain and will require less time for maintenance, thereby increasing the number of M1s available at any one time to unit commanders. With fewer tanks undergoing repair, more are available for combat operations."

All of the M1s now in production at the Army's tank plants at Lima, OH, and Warren, MI, embody the full range of improvements tested by CSTA, and future improvements should further enchance the Army's newest main battle tank.

58 Personnel Will Receive Army R&D Achievement Awards

Department of the Army R&D Achievement Awards will be presented to 58 Army in-house scientists and engineers for outstanding achievements that have advanced capabilities of the U.S. Army and contributed to the national welfare during 1984.

The awards, which consist of a 2-inch cast bronze medallion and a wall plaque, will honor 36 personnel assigned to activities of the U.S. Army Materiel Command, nine assigned to the U.S. Army Corps of Engineers, 10 assigned to the Army Research Institute for the Behavioral and Social Sciences (Office, Deputy Chief of Staff for Personnel), and three employed at elements of U.S. Army Medical R&D Command.

Winners will receive the awards during coming months at the activities where they are employed. Although a number of Army Materiel Command organizational and name changes have occurred during recent months, they are not reflected below because the R&D achievements took place prior to the changes. An announcement of these changes appears in our July-August 1985 issue.

Listed by major commands, subordinate commands and/or the installation where they are employed, the Army R&D Achievement Award recipients are as follows:

A FOG-M missile hits a tank on top, where it's most vulnerable, during a recent test at the Army Missile Command at Redstone Arsenal, AL.

U.S. Army Materiel Command

• ***U.S. Army Electronics R&D Command:*** A team consisting of Dr. Michael Binder, Charles W. Walker Jr., William L. Wade Jr., and Dr. Sol Gilman, all employed in the Electronics Technology and Devices Laboratory, Fort Monmouth, NJ, will receive the Army R&D Achievement Award for important contributions to the technology of primary batteries. Specifically, they performed successful R&D studies on new ultra-safe, long-life high-energy cells utilizing calcium anodes and oxychloride solvents as the cathodic reactants. This new technology has potential application to remotely-piloted vehicles and robotics, as well as to more conventional Army man-portable equipment.

Charles F. Cook Jr., James E. Anthony, Joseph H. Kwiatkowski, Louis C. Poli, and Dr. Gerald J. Iafrate, another team employed in the Electronics Technology and Devices Laboratory, will be commended for their contribution to advancing the state of the art in fabricating nanometer-size millimeter-wave semiconductors and high-speed digital logic devices. This innovative technology, using molecular beam epitaxy and nanometer electron-beam lithography to fabricate a prototype radiator, has resulted in the development of a new class of nanometer semiconducting devices in gallium arsenide. The new radiator offers a much higher operating frequency than most other known electronic devices when operating as a mixer-local-oscillator or self-mixing oscillator. According to the citation, this contribution will provide the Army with microelectronic and microwave technology essential to the Army 21 doctrine.

Ernest B. Stenmark, John T. Marrs, John D. Copp, and James E. Harris, employed at the U.S. Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM, are being recognized for a significant contribution to the Army's tactical forces by allowing, for the first time, the use of weather knowledge as a force multiplier. They developed several mathematical and physical models that transformed weather data into tactical weather intelligence for use by the commander and his staff as a decision making tool. These models are available on both the MICROFIX and the Target Analysis and Planning System and have been provided to more than 50 users. Additionally, the models have been successfully demonstrated by the 9th Infantry Division during training exercises.

• ***U.S. Army Missile Command:*** A team composed of James L. Baumann, Emmitt D. Crosswhite, James C. Hodges Jr., Dr Paul L. Jacobs, Walter E. Jordan Jr., and John A. Schaeffel Jr., all assigned to the Army Missile Laboratory, Redstone Arsenal, AL, are responsible for concept, design development, analyses, simulation, modeling, and flight test evaluation of the Fiber Optic Guided Missile system. They are being cited for their qualitative and effective engineering leadership which materially advanced the R&D effort to demonstrate the application of fiber optics technology to Army weapon systems. The fiber optic guidance system greatly increases the missile's effectiveness, reduces missile costs, increases survivability, and provides additional target location capabilities.

Donald E. Lovelace, Jimmy M. Madderra, Joel E. Williamsen, George A. Sanders III, and Joseph A. Webb, also from the Army Missile Laboratory, will receive the Army R&D Achievement Award for their development of innovative solutions to problems resulting from the integration of the canted warhead technology into

existing anti-tank missiles. The solutions, in aerodynamics, structures, canted warhead design, and missile system dynamics, were proven in missile flight tests within six months of initiation of the effort. This achievement provides a quick response capability for use in maintaining the lethality of U.S. Army anti-tank missiles against future tanks.

• ***U.S. Army Armament, Munitions and Chemical Command (AMCCOM):*** James C. Pearson, employed in the Large Caliber Weapon Systems Laboratory, Army Armament R&D Center, Dover, NJ, will be recognized for a major contribution to munitions technology. His efforts led to a means of improving the effectiveness of existing and future weapons, particularly in the anti-armor role.

Dr. Norman P. Coleman Jr., from the Fire Control and Small Caliber Weapon Systems Laboratory, Dover, NJ, was selected for the award for outstanding technical leadership in developing advanced adaptive weapon pointing, tracking, and platform automation technology which provides a low cost, high performance, fire-on-the-move capability against maneuvering/evasive targets and for developing a highly promising approach to the integration and automation of on-board sensor processing, fire control and weapon platform control functions.

Dr. Edward W. Stuebing, employed in AMCCOM's Chemical Research and Development Center (CRDC), Aberdeen Proving Ground, MD, will be commended for his outstanding research leadership of the aerosol science program at the CRDC. His citation states that he contributed immeasurably to aerosol research and its application to military obscurant smokes for screening combat operations and to defense against chemical and biological attacks. Stuebing is the acknowledged Department of Defense expert in aerosol research and its application to military obscurant smokes, to laser countermeasures, and to defense against chemical and biological attacks.

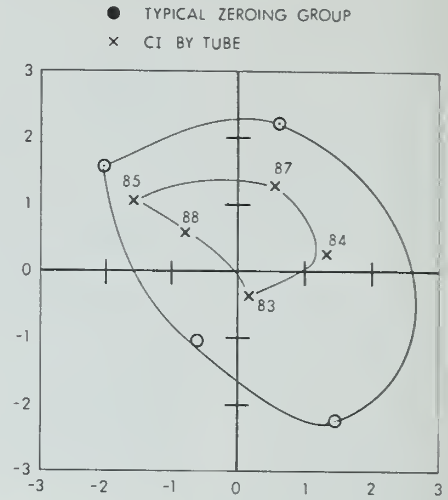
Joseph Huerta, also employed in the CRDC, will be honored for conceiving a new and innovative projectile configuration which has been shown to possess exceptional performance characteristics when applied to small arms ammunition. The unusual projectile shaping provides unique terminal effects in an accurate and easy to produce ammunition. This basic technology can also be exploited for other Army munition systems.

CRDC employee Dr. Orazio I. Sindoni will receive an R&D Achievement Award for development of a new fundamental theory of the interaction between light and particles of matter. This theory allows the prediction from first principles of the light scattering properties of small particles such as aerosols, and has led to the discovery of new phenomena in electromagnetic scattering of small particles. This advance is important to the development of a new generation of military screening smokes and to optical methods for detecting chemical or biological aerosols.

Dr. Timothy P. Karpetsky, also employed at the Chemical R&D Center, will be cited for his outstanding leadership in CRDC's Toxin Defense Program. He determined that significant increases in toxin defense capabilities could be achieved by exploiting biotechnology and micro-sensor technology in unique design concepts. Karpetsky established and implemented a program to fabricate a new generation of detectors that work on entirely new principles of simultaneous multiagent detection. The benefits of his efforts are judged to be of exceptional value because they provide a new modular detector having capabilities previously thought impossible.

• ***U.S. Army Ballistic Research Laboratory (BRL), Aberdeen Proving Ground, MD:*** Eugene T. Roecker, a physicist and team leader at BRL, is being recognized for his outstanding technical accomplishments that have led to the successful demonstration of advanced, high performance kinetic energy penetrators suitable for use in new types of soft launch weapons systems. His work has quantified the potential of these new penetrators and established penetration performance benchmarks that will pace future development efforts.

BRL researchers Dr. James N. Walbert and Donald W. Petty are receiving an award for their research and analysis of dynamic phenomena related to the accuracy of tank guns. By designing and conducting a novel series of experiments, these researchers isolated the dominant contributing factors to the anomalous behavior of the M256 120mm smooth-bore tank cannon. Additional benefits of this achievement are the resolution of the tank zeroing problem and the identification of pertinent gun and mount design criteria. As a result of their new calibration procedure, the Army is expected to significantly reduce costs over the lifetime of the M1A1 tank.



Test firing results shown by the inner circle impacts indicate improved accuracy attributable to the work of Walbert and Petty. Outer circle represents the typical dispersion in the zeroing process for tank gun ammunition.

Another BRL employee, Stanley K. Golaski, is credited for his exceptional efforts which resulted in the development of a new processing method for producing controlled metallurgical grain refinements in shaped-charge liners. The significantly increased performance resulting from this new process is considered to be of major importance to the effectiveness of U.S. Army weapons. Definition of this process serves as the basis for military specifications applicable to current and future weapons which utilize shaped-charge warheads.

• ***U.S. Army Materials and Mechanics Research Center (AMMRC), Watertown, MA:*** Dr. Donald R. Messier and Eileen J. DeGuire will be commended for their work in developing advanced transparent oxynitride glasses, a significant contribution to solving the Army's requirement for improved scratch-resistant and ballistically efficient transparent armor for vehicle and munitions applications. Their research revealed the important role of differing precursor materials in controlling the formation of silicon metal precipitates, which render the glass opaque. This work has laid the foundation for new technology which will greatly enhance the capability of optics to function in more severe battlefield environments in future Army systems.

U.S. Army Corps of Engineers

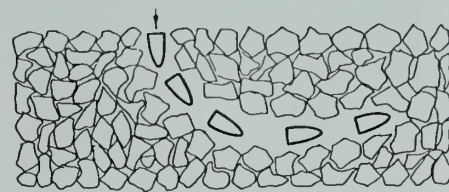
• ***U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, NH:*** Dr. Richard L. Berg, Edwin J. Chamberlain Jr., David M. Cole, and Thaddeus C. Johnson conducted major work to develop frost action predictive techniques used in the design and analysis of military, public road and airfield pavements in seasonal frost areas. The work included field, laboratory and theoretical studies. All phases of the study contributed to the development of a mathematical model which allows the simultaneous calculation of heat and moisture flux during the freezing and thawing of pavement systems.

Fully instrumented soil specimen mounted in triaxial cell for laboratory studies.

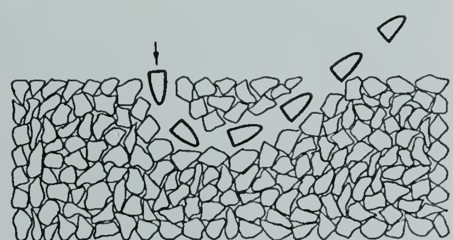
• ***U.S. Army Waterways Experiment Station (WES), Vicksburg, MS:*** Dr. Lewis E. Link, Curtis L. Gladen, and Randy K. Scoggins will receive the Army R&D Achievement Award for their pioneering efforts in fixed-installation camouflage. This research resulted in the first specific guidance for design, application, and evaluation of thermal camouflage for high value assets at military installations. This work provides an immediate enhancement in the survivability of critical military assets against modern threat weapon systems and provides a solid foundation for continued advancements in camouflage technology to match the growth in sensor and weapon capabilities.

Dr. Behzad Rohani, also employed at WES, will be cited for his contributions

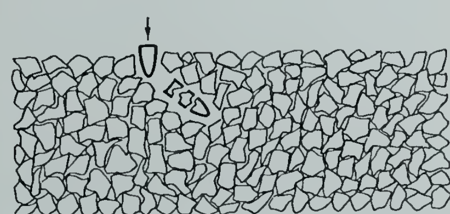
Mechanisms of defeat associated with rock-rubble/boulder screen. Such screens can be used as components of protective systems to degrade the effectiveness of conventional kinetic energy weapons. As the weapon tries to pass through the rock matrix it will experience large obliquity and yaw angles which will cause the projectile to either deflect from its initial path, ricochet or broach, or break up.



a. Path deflection.



b. Ricochet or broach.



c. Projectile failure and breakup.

to military engineering technology. His development of theoretically-sound and experimentally-verified procedures for predicting the penetration performance of high-velocity projectiles impacting geologic and man-made targets has significantly enhanced the Army's capability for solving complex problems involving projectile impact and penetration.

• ***U.S. Army Construction Engineering Research Laboratory, Champaign, IL:*** Ray G. McCormack was selected for the award for his efforts in the adaption of the metal arc spraying technology to electromagnetic shielding and for development of methodology for improving the process. The arc spray technology allows a room to be electromagnetically shielded through a process similar to spray painting. The process can also be applied in laminated panels to improve shielding and is adaptable to robotic automation.

Office, Deputy Chief of Staff for Personnel

• ***U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), Alexandria, VA:*** LTC Robert N. Daws Jr., Christine R. Hartel, Dr. Jonathan D. Kaplan, Arthur Marcus, John L. Miles Jr., Dr. David M. Promisel, Dr. Daniel T. Risser, and Dr. John A. Whittenburg will be commended for their contributions which have materially improved the Army's capability to integrate human factors, manpower, personnel and training considerations into the weapon systems acquisition process. Their achievements as members of a reverse engineering task force and HARDMAN project team have been instrumental in revising the Army's perspective on human factors, manpower, personnel and training. Their work led to adoption of new approaches to acquisition requirements documents and requests for proposals and to widespread application of HARDMAN analysis during early phases of system development.

Dr. Michael H. Strub and Dr. John M. Lockhart, ARI research psychologists, will be recognized for their development of the Realistic Air Defense Engagement System (RADES). This is a highly realistic, instrumented, computer-based test bed for training and evaluating individual air defense soldiers and crews throughout the family of short-range manportable systems. RADES represents the first successful attempt to capture all performance aspects of the air defense engagement sequence from early warning of approaching aircraft to monitoring for effect of firing. RADES targets have been used by the Army Air Defense School to train SGT York gunners in preparing for critical follow-on evaluation testing. RADES has also stimulated concept explorations in such areas as remotely flown rotary wing targets, and realistic training systems which stress identification of aircraft.

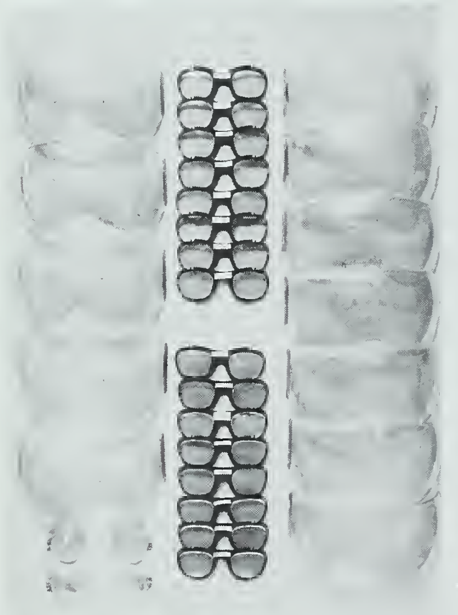
U.S. Army Medical R&D Command

• ***U.S. Army Medical Research Institute of Infectious Diseases, Fort Detrick, MD:*** MAJ Martin H. Crumrine will receive the Army R&D Achievement Award for his contribution to the prevention of botulism. Using modern methods of antitoxin development, toxin purification, and immu-

noassay procedures, Crumrine developed and adapted a sensitive and accurate in-vitro test to rapidly detect the seven distinct types of biological neurotoxins and to diagnose botulism.

MAJ (P) James W. LeDuc made an outstanding contribution to virology and epidemiology as a result of his work on hemorrhagic fever with renal syndrome and the Hantaan viruses that cause it. This work revealed for the first time the existence of an important new group of viruses, defined its broad global distribution and developed the methods to successfully analyze them. LeDuc demonstrated that Hantaan-like viruses are distributed worldwide in domestic rats.

• ***Letterman Army Institute of Research, Presidio of San Francisco, CA:*** COL Edwin S. Beatrice, MC, initiated, organized, and coordinated a massive research effort designed to provide data crucial to the formation of laser safety standards for both military and civilian industrial applications, and to provide all military personnel with ocular protection from directed energy systems. In addition, publication of research results and liaison with other DOD departments served to educate all levels in reference to bioeffects prompted by laser radiation.



Limited production and issue of laser eye protection devices will begin in FY 86, as a result of R&D efforts by the Ocular Hazards Division, Letterman Army Institute of Research. Laser protective visors for helicopter pilots, spectacles for soldiers, and eye inserts for the attack helicopter mask are shown.

Little Known Facts

Recently, concern has been expressed by the Army RD&A community regarding a perceived loss of scientists and engineers (S&E) within the Army Materiel Command (AMC). A closer look at the facts tend to show that this concern may not be well founded. In fact, during the past two and a half years AMC has actually obtained more scientists and engineers than it has lost. For example, during FY83 through the second quarter of FY85, official data indicate a total of 2,494 S&E employee accessions and 1,710 losses. This equates to an actual gain of 784 S&E employees! Losses/accessions by fiscal year are shown below.

FY83	FY84	FY85
640/582	709/1,555	361/357 (two quarters)

New Medical Lab Slated for APG

Preparations are underway for a new medical research laboratory that is expected to bring between 125 and 150 new professional and technical jobs to Aberdeen Proving Ground (APG), MD.

The Medical Research Evaluation Facility will be a 100,000-square-foot laboratory owned and operated by a contractor who will lease five acres of land in the Edgewood Area of APG.

The laboratory, under contract to the U.S. Army Medical Research and Development Command at Fort Detrick, MD, will specialize in research, development and evaluation of compounds to find antidotes, decontaminants and medical equipment for medical management of chemical injuries on the battlefield.

The facility operation will be overseen by the U.S. Army Medical Research Institute of Chemical Defense, the Department of Defense lead laboratory in conducting research, development, testing, and evaluation in support of medical defense against chemical warfare. The institute reports to the Medical R&D Command.

The contractor will pay for the building's construction and initial costs for going on-line. The building itself is expected to cost about $20 million. The contract, including construction, equipment, personnel, and operation, is expected to total about $80 million, which will be funded over a five-year period by the U.S. Army Medical R&D Command.

The competitive bid procurement process is expected to result in a contract award in November 1985. The contract will call for the first of three phases of the project to be constructed and operational within 18 months of the contract's award.

Phase I will be a modern animal care and holding facility which will be inspected and accredited by the American Association for the Accreditation of Laboratory Animal Care.

Phase II includes the experimental/chemical exclusion area. This is the major portion of the Medical Research Evaluation Facility operation, used for researching the four primary areas in the medical chemical defense program: pretreatments and therapies, or antidotes; decontaminants and protectants; medical management of chemical casualties; and combat effectiveness and sustainability of the American serviceman in a chemical environment. This area of the facility will incorporate the most advanced technological safety features, including redundant air filter systems, backup power supplies and laboratory hoods.

Phase III will be administrative office space. All three phases are expected to be operational in 1989.

Design Engineers Field Experience With Soldiers

By CPT Lawrence E. Rautenberg

The U.S. Army slogan, "Be all you can be," is being taken quite literally by a small group of civilian design engineers assigned to the Army Armament, Munitions, and Chemical Command (AMCCOM). These men and women elected to spend from two to four weeks with Regular Army units, living and working alongside soldiers while participating in field exercises. These volunteers signed up for a program named DEFEWS, an acronym for Design Engineers Field Experience With Soldiers.

Purpose

The DEFEWS Program was created to allow key managers, scientists and design engineers to acquire a first-hand knowledge of the environment in which soldiers and their equipment must function. DEFEWS emphasizes foxhole-level experience by permitting participants to become a member of an Army squad, crew or team, living with soldiers in a simulated combat environment while using the type of equipment they (the civilians) are employed to design or improve in their regular jobs.

The DEFEWS participants wear camouflage uniforms, carry protective masks and rucksacks, and serve in positions ranging from machine-gunners in an infantry squad to crew members of chemical decontamination equipment. They spend anywhere from two to four weeks in the field.

The knowledge gained by the participants is translated into design considerations and product improvements which should lead to an increase in equipment maintainability, reliability, combat performance, and overall troop acceptance of the equipment/weapons.

A large majority of Department of the Army civilian design engineers have never had any military experience. They were not drafted, going from high school to college, then to work for the U.S. government. Quite naturally, they lack a complete understanding of the environment of, and the interface between, the soldier and his equipment. DEFEWS is a mechanism to bridge that gap. To quote a female participant: "The primary reason for the program is to gain information on how it feels for the soldier out in the field. We were out there to learn how to design a better piece of equipment for the soldier. When you come back, there is a much keener understanding of the manner in which soldiers interact with each other and their equipment, and a sharing in their frustrations with the supply system and breakdowns."

Despite the obvious benefits inherent in the DEFEWS Program, participation is not for everyone. Candidates must possess a certain amount of dedication and mental and physical toughness; a soldier's life in the field is demanding and stress-filled; hot meals, adequate sleep, and good weather are the exception, not the norm. It takes a very motivated engineer to exchange the comfort and safety of his daily routine for long hours without sleep in an environment for which he is not trained.

Selection Process

First, and foremost, the prospective DEFEWS "soldier" must be a volunteer. A volunteer must be committed to finishing what was started; the individual and the government both get the maximum return for the effort and funds expended during the training.

Second, he must have his supervisor's approval . . . . after all, the boss must decide if his budget can afford the TDY expenses incurred. Also, can he afford to lose a member of his office for 14-30 days? And of course, is there a valid need for the worker to participate in DEFEWS? For example, an engineer working on a sub-caliber training device for a pistol, which will only be used on firing ranges, has no need to spend two weeks participating in range firing; his design considerations are fairly well established. That same engineer, however, working on proposed improvements on the M60 machine gun, would benefit greatly by working alongside an infantry squad during an Army Training and Evaluation Program. He would have the opportunity to maintain, fire, and carry the machine gun, as well as observing how the weapon is used in tactical situations. He can also speak directly with the soldiers who use the weapon on a daily basis, and get feedback/desires for future product improvement programs.

Third, the volunteer must be in good physical condition. Prior to being sent to a host unit, the candidate is given a standard military physical examination. He is also required to take and pass the Army's Advanced Physical Fitness Test (APFT), consisting of pushups, situps, and a two-mile run. The APFT is graded to the same standards which are applied to Regular Army soldiers. The physical examination and the APFT (in conjunction with the physical training program most candidates put themselves on) combine to ensure that the DEFEWS participant is in reasonably good shape and will be able

M60 RISE (Reliability Improved Selective Equipment) engine is no problem for DEFEWS participant Arthur Savarese, an engineer from the Large Caliber Weapon System Laboratory, Dover, NJ, training at Fort Carson, CO.

Donna Smith, engineer at Chemical R&D Center at Aberdeen Proving Ground, MD, during training at a Fort Hood, TX, NBC exercise.

to keep up with the physical demands of life in the field.

Program Management

The testing, outfitting and general preparation of the candidates for the field, plus the coordination necessary to find a suitable host unit for him, fall to AMCCOM's Armament Research and Development Center (ARDC), located at Dover, NJ. A combat arms officer from the Requirements and Analysis Office is assigned as the AMCCOM DEFEWS program coordinator. The Chemical Research and Development Center (CRDC, also part of AMCCOM) and the Ballistic Research Laboratory (BRL), located at Edgewood and Aberdeen, MD, respectively, are also participants in DEFEWS. A combat arms officer at CRDC manages his (and BRL's) involvement in the program, and works directly with the program coordinator at ARDC.

The program coordinator at ARDC, and his counterpart at CRDC, are responsible for publicizing the program; interviewing, screening and testing candidates; and equipping them. The program coordinator at ARDC is responsible for coordinating with the U.S. Army Forces Command (FORSCOM) and its units to arrange for appropriate host units.

Candidates are made aware of DEFEWS in a variety of ways, ranging from supervisor recommendation, former participants talking up the program, an annual letter soliciting volunteers, and even a DEFEWS picnic (organized by former participants).

Workers who are interested in the program contact the program coordinator at ARDC or CRDC, and receive a detailed briefing on DEFEWS. Topics covered include the purpose of the program, a description of the program, the field duty environment, physical training requirements, and expected conduct of behavior while training as a "soldier." The fact that the candidate will not be treated as a VIP is stressed; the aim of DEFEWS is to allow the civilian to experience the positive and negative aspect of the soldier's life in the field with his equipment.

Those who subsequently volunteer (either to participate in valuable training, or to have an adventure) are medically examined and physically tested, and as soon as possible are sent to join FORSCOM units in the field.

It is worth noting that while FORSCOM does not require any of its units to act as hosts for DEFEWS candidates (FORSCOM supports DEFEWS 100 percent, yet allows its individual divisions and separate brigades to volunteer to host the DEFEWS civilians), almost every major Army installation in the Continental United States has had at least one DEFEWS candidate participate in major training exercises alongside its soldiers.

Applications

DEFEWS "soldiers" have marched as members of a light infantry squad, crewed mortars, and loaded and fired M1 tank main guns during gunnery tests. They have also gone to the field as members of 155mm and 8-inch howitzer crews, worked with chemical companies in personnel and vehicle decontamination, and handled smoke-generating equipment. Some participants have created minefields and obstacles, and some have trained in extreme climatic conditions, i.e., Alaska in the winter, and in the desert at Fort Irwin, CA, in the summer.

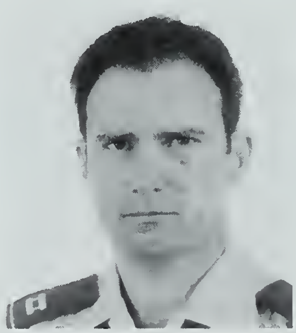
River crossing operations, five-mile runs at seven and a half minutes per mile, exposure to CS (riot control) gas, digging and filling in foxholes, guard duty, force-on-force exercises with Multiple Integrated Laser Engagement System training devices, and dozens of other experiences have been recorded by DEFEWS participants ranging in grade from GS-6 to GS-14, from new interns to veteran PhDs. The comments made and trip reports written by the "soldiers" have all praised the program as an excellent learning experience, and replies from host units have been equally laudatory.

Summary

DEFEWS, currently an AMCCOM program, is in the process of being expanded into a program which will allow participation by all elements of the Army Materiel Command (AMC). The program will continue to be managed by ARDC, for AMC. Each major subordinate command will be able to place volunteers in FORSCOM units using the criteria developed and refined by ARDC and CRDC.

The DEFEWS Program has proven itself to be a viable and worthwhile program. Given a minimal expenditure of funds and time, individuals who have had limited or no exposure to soldiers and their equipment can become fairly knowledgeable concerning the way soldiers use a particular weapon or system. In this day of increased emphasis on shortening materiel acquisition time, reduced costs, and increased Manpower and Personnel Integration and human engineering considerations, the DEFEWS Program can play an important role.

More information about the DEFEWS Program may be obtained by calling CPT Lawrence E. Rautenberg on AUTOVON 880-6974.



CPT LAWRENCE E. RAUTENBERG is chief of the Close Combat, Light, Team in the Requirements and Analysis Office, Concepts and Requirements Division, U.S. Army Armament Research and Development Center. He has a B.A. degree in history from Christopher Newport College.

Materiel Fielding Teams for Large Complex Systems

By COL Donald H. Jones and CPT(P) Philip E. Hamilton

Today with the proliferation of over 400 new systems into the Army's equipment inventory, a Materiel Fielding Team (MFT) has the responsibility of being at the forward edge of large system fielding. The MFT experiences a continuous, close, physical contact with the user. Until fielding, the program management office (PMO) only encounters this contact during the short intervals associated with development, testing and initial fielding in-process reviews.

In January 1985, the Bradley PMO was reorganized as an "umbrella" PMO for the Light Combat Vehicle, thereby placing responsibility for the M113 family of vehicles, M9 Armored Combat Earthmover and the Field Artillery Ammunition Support Vehicle under its control. Although the figures in this article show the Light Combat Vehicle organization, we will limit ourselves to the Bradley Fighting Vehicle fielding experiences.

Since March 1983, the Materiel Fielding Teams, as an extension of the program manager, Light Combat Vehicle and the project manager for the Bradley Fighting Vehicle System have handed off 900 vehicles at Fort Hood, TX, and in Europe. The original mission and scope have been increased, but the one true objective has always been to go out of business when the system is ready. Currently, the MFT goes out of business one battalion at a time at the completion of the battalion field service representative's tour of 10 months. This tour is being reduced to six months. The additional field service representatives that we gain from the shorter tour will support our expanding role in Prepositioning Of Materiel Configured to Unit Sets (POMCUS) and Theater Reserve.

Mission Evolution

Although fielding began in 1983 for the Bradley, the PMO, the Army Forces Command and U.S. Army Europe conducted several meetings to develop fielding agreements and plans in 1981-82. As the MFT's mission and scope of responsibilities were being formulated, based on the fielding agreements, the PMO structured the MFTs for CONUS and OCONUS. Our OCONUS MFT is shown in Figure 1. Simply put, the MFTs would receive, deprocess, issue and sustain the Bradley vehicles, tools, technical manuals and Test Measurement Diagnostic Equipment (TMDE), during a special support services period. This period equates to the time it takes a battalion-size unit to inspect and draw the equipment, then complete a structured transition training period. This is generally 90 days for an infantry battalion and 60 days for an armored cavalry squadron. This requires vehicles, tools, technical manuals, and TMDE to be on-hand for deprocessing and inventory 30-60 days in advance of fielding.

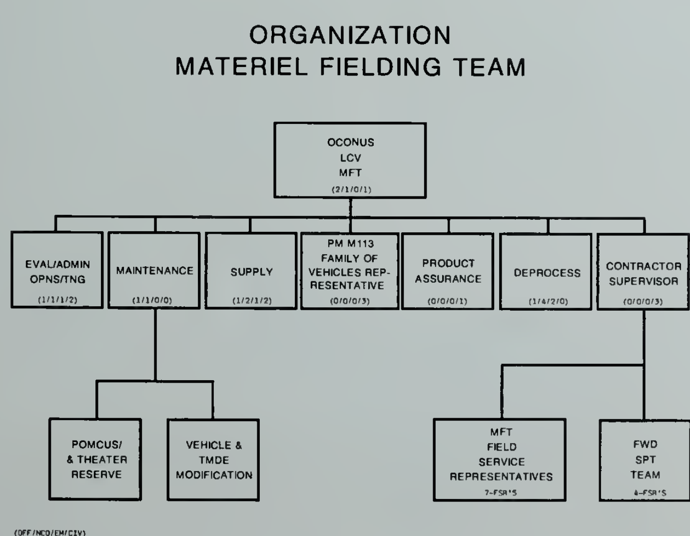


Figure 1. Organization of the OCONUS Light Combat Vehicle MFT.

For our OCONUS Materiel Fielding Team, fielding was not only to active units in USAREUR, but also for POMCUS and Theater Reserve. During this first two years, the MFT has conducted fielding operations with organizations all over Germany, in Luxembourg and now we are coordinating with storage sites in the Netherlands.

Other activities have included the management of modification programs for the vehicle and TMDE, and our assistance in the maturing of the parts supply system. Modification programs to improve component reliability and correct design or manufacturing errors have been accomplished at the unit's home station. Here, the use of facilities, equipment and personnel must be carefully coordinated to minimize interference with unit training. This coordination has become an MFT responsibility.

The maturing of a new weapon system parts supply is a function of timely data, training and documentation. The MFT becomes the program manager's eyes and ears in the field to surface problems in these areas quickly for timely resolution. The initial parameters used in the provisioning models for the Prescribed Load List (PLL) and Authorized Stockage List (ASL) are based on engineering estimates and initial production testing. The procuring commands (TACOM, AMCCOM, MICOM) are limited by the same provisioning models for the depth of ASL/PLL quantities until these are refined through fielding and demand experience. Therefore, requirements must be placed on the repair parts system as early as possible to accommodate the procurement and production lead time. A critical fielding parameter now is to achieve 100 percent fill in mission essential items.

In the case of the Bradley, the original ASL recommended by the contractors and government engineering and test data was over 2,700 lines. In the two

years this has been reduced to a demand-supported ASL of 855 lines. Upon implementation of the policy to include only mission essential items in the ASL, this will drop to approximately 700 lines.

This significant accomplishment could not have taken place in this short period and still effectively sustain the system without the analysis and documentation of parts usage and component failure rates at the CONUS and OCONUS MFTs. The fielding teams accomplished this by documenting all failures during transition training, in units, on special exercises (REFORGER and National Training Center) and during the deprocessing of equipment prior to issue. This documentation categorized failures by vehicle serial number, fault, availability of parts, time, and maintenance level for repair.

The parts availability, on-hand, non-stocked line and zero-balanced data, coupled with time/location for repair, has been used to adjust the fill of parts at the various levels of maintenance. In order to gather this data, weekly telephonic contact with the division material management staff, depot personnel, and the POMCUS and Theater Reserve storage sites was required. The part demands from transition training were also used for trend analysis. At each repair parts review these data were compiled and presented by the MFT to using units and the materiel readiness commands as additional intelligence to speed the maturing of the system. It also gave direct support, general support and depot organizations feedback on how long it took to evacuate a component, repair it and get it back into the supply system.

Based on the documented lessons learned, failure data and configuration changes, the MFT can assist the new equipment training team in making program-of-instruction changes, modifying tasks or emphasizing key training elements. Quickly developed short courses offered by the MFT can also be accomplished using military instructors and contractors until the training community can institutionalize the new concepts. For example, during early fielding, the Bradley MFT's data showed two valve assemblies failing on the transmission. The contractor representative assigned to the fielding team developed and presented a block of instruction to teach the proper diagnostic and repair procedures to direct support maintenance mechanics, thus eliminating the need to remove the transmission and evacuating it to depot. Concurrently, the PMO and contractor pushed improved valve assemblies to the units and MFTs while changes were being made on the production line. This systemic approach has been successful for other short term problems we have experienced.

A longer term process evolved for diagnostic training. Early fielding saw a need for the senior NCOs and warrant officers to obtain more in-depth training than was being provided to their soldiers. In new equipment training, the maintenance leadership went through training along with their soldiers. The MFTs and contractors developed a short Senior Diagnostician Course for both turret and hull diagnosis. The original courses were scheduled by the fielding teams and conducted by the contractors. Now, TACOM and AMCCOM have taken over this training function in CONUS and OCONUS until the Ordnance Center and School (OC&S) can begin formal classes.

As we have shown, our original mission has increased in scope as the fielding team has stepped forward to fill unpredictable holes in the sustainment of a new weapons system.

MFT Fielding Model

The philosophy is that sustainment actions by the MFT must serve to mature the system faster and lead to the formulation of a basic fielding model for large systems.

Sustainment requires two-thirds of the MFT's effort. Two years ago this was not the expectation of the Materiel Fielding Team members. Early ideas centered around the deprocessing and hand-off of equipment followed by some elementary data collection on known problem components or intensively managed items.

Once fielding has been initiated, the primary role of the fielding team should become one of a facilitator, communicator and documenter. Our MFT serves as a point of contact within the Army Materiel Command for all actions, questions, and problems that relate to the Light Combat Vehicle family. Our ability to accomplish this has been enhanced through a computer system which includes automatic data processing terminals to enter and format data, word processors to document the analysis, and data links to the PMO, test facilities and contractors to speed communications. The PM, Light Combat Vehicles communication network is extensive. This network enables the PMO to maintain a current information system with each element to communicate trend analysis, update fielding milestones and document a system's maturity. The MFT uses this communications network daily to gain quick, systematic action on a problem or to update the PMO and others on follow-on actions.

With the first fielding of Bradley in USAREUR, the fielding team began hosting monthly and, now, quarterly fielding forums. Attendees are from units in various phases of fielding; division, corps and theater support organizations, and AMC Logistic Assistance Officers and Logistic Assistant Representatives. Here, the MFT expands its fielding network to the user and its support units. With the MFT on "the forward edge," the forum and computer links allow the MFT to work as a catalyst for information flow, sharing of lessons learned and problem solving. What emerges is a fielding system which "navigates" itself to a successful fielding (see Figure 2). The Materiel Fielding Team is the organization that can cross boundaries and tap the experience, knowledge and motivation of those in the fielding system.

To have a capable MFT requires the leadership to fine tune the team members into a proactive, high performance organization. They have to be capable of analytical thought to spot trends, while being tempered with a knowledge of the environment in which the system is op-

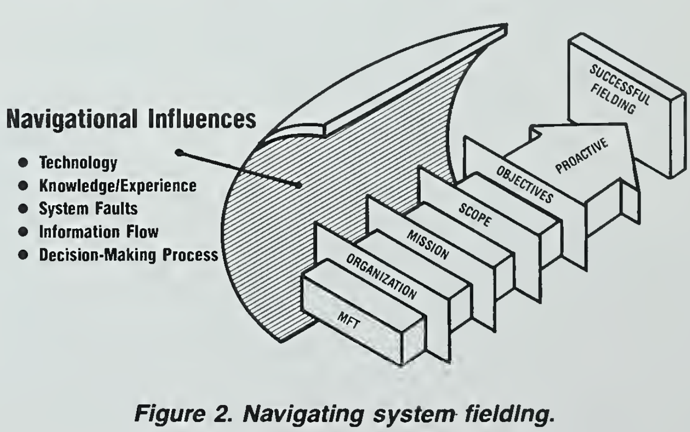


Figure 2. Navigating system fielding.

erating. When we observe problem areas relating to the Bradley, they are analyzed using a systemic approach:

- What were the conditions?
- What level of expertise does the unit have?
- Have we seen this before?
- Is it a problem in design, quality, supply, training documentation, doctrine or a combination?
- Can we slow the trend until an effective analysis can be performed?

The network is then accessed to gain additional data or analysis assistance. In some cases a contractor and/or program manager's position may be necessary before the MFT's decisions, actions or recommendations can continue.

Proactive System Fielding

Some of the traits of a proactive MFT are as follows:

- Organizational design uses matrix and network problem solving. This method quickly gathers the necessary information, draws on the expertise of many and provides swift dissemination of the corrective action(s).
- Decisions are made with an understanding of the environment. The analysis for courses of action take into account the impacts they may have on other elements of fielding and (most importantly) the unit.
- The short term fix is not the answer. It may relieve the pressure temporarily, but the time gained must be used to solve the problem for the long term.
- Team member responsibilities are flexible. This allows members to pull out of their normal function and work a critical issue without decreasing the MFT's capabilities. This requires cross training of staff and a sharing of information between members. We have chosen to take staff officers or NCO's to meetings or in-process reviews outside their responsibility and route daily reading files within the MFT. These files contain all correspondence received or sent by the MFT. Sometimes we pay a price for this, but it pays off when anyone answering the phone can speak generally on a subject and/or at least knows who to go to for an answer.
- The MFT takes responsibility for seeking out potential problems and providing answers to the field before the units experience them.
- Lessons are shared with other force modernization elements.

Achievements

The proactive approach to fielding that we have taken on the Bradley is yielding a sustainable system. Although we still must intensively manage items and continue to identify areas we must improve, the network is in place to accomplish this efficiently. Some of our success bears review.

First, we have made the unit self-sufficient. Having soldiers do the work first reinforces their training and prepares them for when the field service representative moves on to another gaining unit. Shortages of equipment, TMDE, tools, technical manuals and repair parts have been minimized so the unit has the mission essential items necessary to do its job. Additionally, the units and Logistic Assistance Officers have sent personnel to work directly with our deprocessing team to gain additional exposure to system experts. This has greatly enhanced their knowledge and the Materiel Fielding Team is able to reinforce correct procedures.

Secondly, we have always sought to improve our knowledge and skill level, and then transfer these gains to the fielded units. This transfer occurs through a quarterly forum, during unit visits and in short training sessions.

We continuously utilize a team approach to our mission which involves the PMO, new equipment training team, Logistic Assistance Officers/Logistic Assistant Representatives, gaining units, and contractors. Many of these relationships have been documented in negotiated support agreements.

When we started fielding two years ago, the ASL was 2,700 lines; too large for divisions to effectively manage and too costly for the procurement agencies. Today, it is a quality ASL at approximately one fourth the size. Also, the depths of those lines are fully demand supported. Our experiences on REFORGER 84 and 85 proved this point by maintaining 98 percent operationally ready rates without the PMO providing parts from outside the system.

We are now completing negotiations with USAREUR and AMC-Europe to reduce, from 10 to six months, the length of time a field service representative is with the unit. This will reduce costs and allow us to better support POMCUS and Theater Reserve storage sites.

Lastly, the modification program is in its final stages of contractor application. Henceforth, modifications will be accomplished through modification work orders. Throughout this program we have been extremely sensitive to the impact of modifications and their application on a unit's mission capable status and training. Modifications, applied to date, have improved the reliability of selected components by over 500 percent and have eliminated potential safety problems.

As our epilogue we would like to say being proactive and documenting has paid off. The Government Accounting Office summed it up during a visit to the OCONUS Materiel Fielding Team by focusing on the need to institutionalize aspects of the Bradley fielding program, particularly recording, documenting and reporting procedures. As our epitaph, we would like Bradley units to say we went out of business when the system was ready.

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AirLand Battlefield Environment Thrust

By Bob O. Benn and CPT(P) Michael J. Van Atta

In 1982 the U.S. Army Corps of Engineers initiated a significant effort, the AirLand Battlefield Environment (ALBE) Thrust, for the purpose of supporting and guiding combat operations research and development in the area of environmental sciences.

ALBE is directed towards the support of materiel acquisition, training and doctrine development and the development and rapid fielding of combat operations decision tools to exploit the battlefield environment. ALBE is intended to meet, with specific products, an important Army need.

The ALBE initiative focuses research on the Army's realistic battlefield environment problems, a requirement that has high priority because the weather and terrain have such a dramatic impact on practically all systems and operations. The atmospheric, terrain, and systems technology emerging from laboratories participating in the ALBE effort are highly integrated in order to achieve a coordinated, efficient and effective environmental sciences R&D program.

What is ALBE?

ALBE is a research, development, test and evaluation program thrust concerned with the environment characteristics, conditions, and interactions that impact on materiel development and tactical forces. Its purpose is to develop and expedite the fielding of the technologies needed to exploit the environmental influences on both friendly and threat weapons systems and operations and to use the environment as a combat multiplier.

Goals, Objectives and Needs

The ALBE effort has two major defined goals. The first goal is to support combat readiness through research and development in the environmental sciences in support of basic research, training and doctrine, and the weapon system development communities. The first goal is to provide a better understanding of what natural and battlefield- induced effects are, how they can be measured, and how they can be predicted.

The second goal is to support combat operations. This is achieved by focusing efforts on the evaluation of U.S. and threat systems and their operational capabilities in battlefield environments and the development of the capability to acquire, process and analyze environmental data and use it to generate and display tactical decision aids for the commander in near real-time.

The ALBE Thrust was initiated to guide the Army environmental sciences RDTE efforts in solving problems in operating in realistic battlefield environments. The impact of the battlefield environment on military activities and equipment is of great significance for the following reasons:

- Historically, environmental conditions have had a significant impact on combat operations.

- Current high technology weapons systems are increasingly more vulnerable to natural and battle-induced environment influences, such as moisture, smoke, temperature, and dust.

- In planning for strategic forces deployment, the worldwide ranges of climate, terrain relief and vegetation are used as considerations in determining force packages, weapons systems and logistical requirements.

- There is a need to reduce, through automation, the time intensive Intelligence Preparation of the Battlefield (IPB) process which includes analysis of meteorological and geophysical information in the tactical area of operation.

It has only been during the last decade that significant technological advances have been made in the development of remote sensing sensors, remotely piloted vehicles, lasers, computer algorithms and related hardware, systems analysis, and in understanding environment effects quantitatively. These advances permit quantitative information to be produced to accurately access and predict the influence of the environment on weapon systems performance and operations.

Finding Solutions

The solution to problems of environment impact assessment on weapons system effectiveness, NBC assessment and predictions, mobility analysis, countermobility analysis, intelligence gathering through remote sensing, more effective self-contained munitions use, sensors and new technology for remotely detecting minefields, and other ALBE-related topics are being met through the development of tactical decision aids for staff and commanders to use in preparing their battle plans.

The tactical decision aids provide information necessary to the IPB process and to the accurate analysis of courses of action in real or near-real time. Normally, information is presented as an overlay or graphic display relative to a specific course of action, for an easy-to-understand visual assessment of the battlefield. For example, in order to evaluate avenues of approach, meteorological conditions are projected and the resulting data used in conjunction with topographic relief, vegetation, natural and man-made obstacles, soil conditions and other terrain features to evaluate the environment's impact on friendly or threat forces. With the use of battlefield intelligence automation, it is possible to perform this task much faster with a much higher level of accuracy, and provide the output in a more usable form than presently available.

The Engineer Command and Control Automation System (ECCAS) as well as several other command and control family systems will incorporate major aspects of ALBE products. It is particularly appropriate to mention the ECCAS connection since the terrain teams have a large part of the responsibility for data gathering and processing, and terrain product preparation for the commander and his staff in combat.

As a prerequisite, the ability to provide decision aids requires the capability to calculate certain dynamic characteristics such as line-of-sight engagement opportunity and mobility and background target signatures. Such dynamic characteristics are dependent on the systems,

the environment, and their interactions. Rapid production of intelligence-aid products also requires an ability to process, store, and have available certain static data required for decision aid real-time calculations. Static information, such as soils, topographic relief and system performance characteristics can be prepared far in advance of any conflict and maintained in a digital computer format just as maps are maintained now in a paper format.

One must also have the real time capability to gather, process, store and use time-dependent information such as weather. There are sub-efforts within ALBE geared towards developing sensors, equipment, and software to meet those requirements. ALBE is also concerned with mechanisms for processing and storing data, and for performing the calculations necessary to produce displays on video screens, as map overlays, and in tabular form.

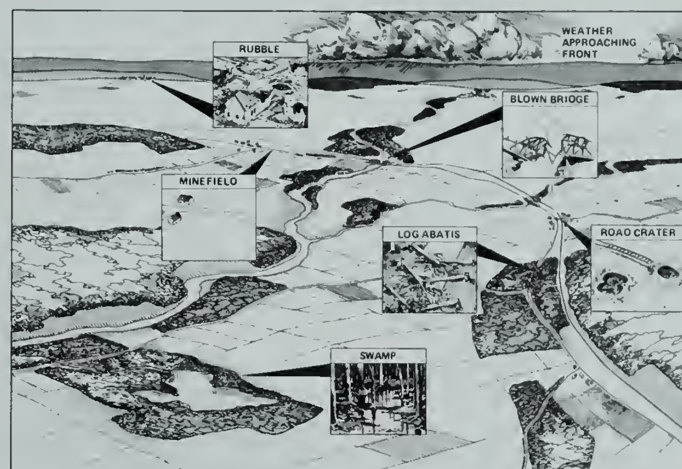
The objective in providing the tactical decision aids is to give the field commander an opportunity to see, synthesize and accurately analyze intelligence information of a much higher quality and of a more comprehensive nature than presently available so as to better choose his course of action. ALBE provides weather and terrain intelligence products and the commander uses them to make decisions.

Who is Involved?

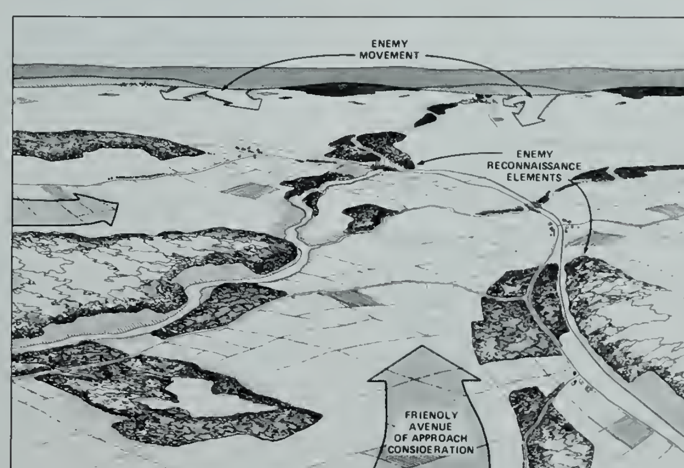
This multi-lab coordinated effort involves the Corps of Engineers and several Army Materiel Command laboratories. Program guidance is provided by HQ, Army staff; assistant chief of engineers; assistant chief of staff for intelligence; Training and Doctrine Command (TRADOC) Support Office; HQ, TRADOC; and other user and HQ staff organizations. The technical participants in the ALBE effort are the following laboratories with representation on the ALBE Executive Committee, ALBE's board of directors: Atmospheric Sciences Laboratory, Army Materiel Systems Analysis Activity, Construction Engineering Research Laboratory, Chemical Research and Development Center, Cold Regions Research and Engineering Laboratory, Engineer Topographic Laboratories, Program Manager for Smoke/Obscurants, and the Waterways Experiment Station.

The Directorate of Research and Development, Office of the Chief of Engineers, directs the program and chairs the

The ALBE concept utilizes existing and future data collection sources to gather real time information on weather, terrain, soil, vegetation, obstacles and enemy location and sends to an all source collection point for analysis and distribution to field commanders.



During the analysis, man-made and natural obstacles are located and identified. Weather fronts are plotted for future impacts on mobility. This information is then graphically displayed on video monitors or on map overlays for commanders to use in planning their avenues of approach.



The location and movement of enemy forces is plotted and analyzed. Friendly avenues of approach are analyzed against known obstacles, predicted weather and trafficability and presented in a visual display for the commander's war gaming.

ALBE Executive Committee. The laboratories execute the program under the guidance of the chairman of the executive committee, who is assisted by an executive agent and a demonstration manager. The Army Development and Employment Agency is supporting the demonstration and evaluation of ALBE products. ALBE is also closely coordinated with the Joint Tactical Fusion Program and MICROFIX.

Products

Some examples of the current capabilities developed from the ALBE initiative are as follows. In nuclear, biological, and chemical hazard prediction, it is possible to predict the time dependent dispersion of chemical agents. A commander can use this automated procedure to determine contaminated areas that should be avoided, how long the contaminants will remain in the area, where he should be in mission oriented protective posture gear, how long he must remain in the gear, and areas that would be useful for decontamination facility placement. Also, the effect of munitions-generated smoke and obscurants on visibility as a result of artillery or mortars can be estimated.

There is an ability to accurately calculate speeds of U.S. and threat vehicles, both on and off-road, for practically all environmental conditions. Products associated with this capability are usually provided graphically in video or paper format for the commander's specific area of operation. Areas where the commander has a speed advantage, based on present or projected weather conditions, can also be shown.

Another ALBE contribution is in gap and obstacle crossings throughout an area of operation. Engineering efforts required to cross streams, gaps, or other obstacles can be automatically analyzed, identified, and displayed on a computer-generated map. Current examples of these tactical decision aids can allow commanders to rapidly analyze high speed avenues of approach and better plan operations.

Remote sensors able to perform minefield stand-off detection are also being worked on. This will allow the commander the capability to remotely detect emplaced mines, allowing him sufficient time to decide whether to bypass or breech the obstacle. The analysis of sophisticated self-contained munitions sensors can automatically provide map overlays showing where a high probability of obtaining hit and kill on threat vehicles can occur in order to assist in planning interdiction fires.

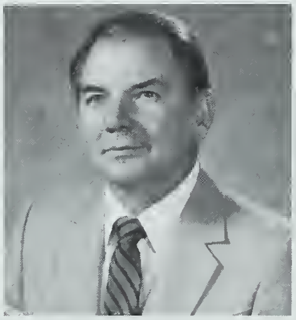
Opportunity-for-engagement data can be provided for use by the commander in siting radars, radios and repeater stations, and direct-fire weapons. These data, in the form of map overlays for the commander's area, provide an opportunity to gain a synoptic "view" of the areas that he covers, and where systems should be sited to improve coverage.

Other sensors have been or are under development, for providing basic data required for dynamically monitoring the state of the battlefield, including conditions unique to cold regions. Atmosphere and terrain sensors, such as meteorology packages, a miniaturized soil moisture sensor, and obscuration measuring devices complement data now collected in combat and provide a means for reducing the soldier workload while improving accuracy.

Summary

The ALBE effort began in the fall of 1982 and has continued to gain recognition and support throughout the Army. Selected ALBE technology demonstrations, some in conjunction with the Air Weather Service, have been held since 1982. Technology demonstrations are demonstrations of significant, in-depth technical capabilities, which are precursors, usually in a benign situation, of field demonstrations. Multiple-laboratory technology demonstrations will be conducted in late 1985 and in 1986 in the United States and in selected OCONUS locations including Germany and Egypt.

Beginning in 1987, the first of a series of major field demonstrations, with formal Army evaluation review, will be conducted by the Army Development and Employment Agency at Fort Lewis, WA, to test and evaluate capabilities that are field operable, have high potential payoff, and are combat supportable. The field demonstrations are embedded in a "fielding strategy" to drive the products to the tactical forces as soon as possible.



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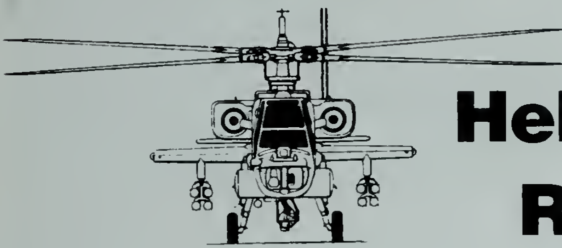
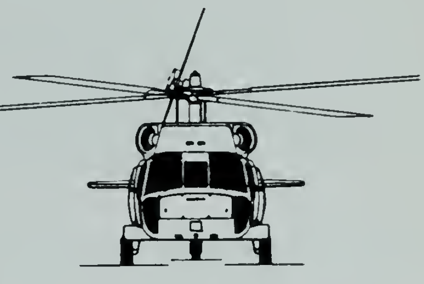


Helicopter Reliability Assessment



By Jim McCrory

Reliably . . . reliability . . . reliable. These are terms used to define that characteristic of "trustiness" that we want to ascribe to things, particularly vertical lift, heavier-than-air things. After all, those are a frightening combination of rotating gears, shafts, bearings, sprockets, blades, and turbines interconnected by a labyrinth of cranks, wire bundles, black boxes, and linkages.

Back in the dark ages of concern for reliability, this desire for "trustiness" was often expressed by simply stating that these things "should be reliable." No one knew exactly what this meant except that the machines should do whatever they were designed to do without failing very often. The problem, of course, was that a concept of "not failing very often" meant one thing to one person and entirely something else to another.

Lord Kelvin, that noted English physicist and mathematician, commented "I often say that when you can measure what you are speaking of, and express it in numbers, you know something about it; but when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be."

Reliability Expressed in Numbers

Equating reliability to "not failing very often" may have been the beginning of knowledgeable concern, but it was clearly of a meager and unsatisfactory kind. As a consequence, this desire for trustiness, for reliability, came to be expressed in numbers. Probabilities of accomplishing a mission or functioning successfully and mean-time- between-failure became familiar terms in the lexicon. However, to express reliability requirements as numbers, measurements involving operating time, cycles, trials, and failures were required. This, in turn, opened Pandora's box of questions that required answers. What constituted a failure? A trial? A cycle? What was operating time? When did it begin and end? Everyone had ideas, but getting them down on paper in some definitive manner, something with which everyone in the development chain from manufacturer to user could agree upon, was a considerable challenge.

Seemingly, however, reliability was now on a sound footing. After all, it had been quantified. Unfortunately, sometimes that expression of reliability in numbers was not based on systematically developed requirements. *One hundred* and *one thousand* are such nice, round, full, comfortable, and seemingly complete numbers; they were often pulled out of the air to express this desire for trustiness. If the ancient Hebrews had been writing the requirement documents, they might have pulled *seven* out of the air since, to them, it signified wholeness. Obviously 100 percent was not a word in the reliability dictionary. It was simply unattainable. Additionally, it became apparent that a mean-time-between-failure of 100 or even 1,000 hours might not be what was really required for helicopters. As more systematic assessment of requirements has occurred; as the complexity and cost of hardware have increased; and as more and more of man's functions in these vertical lift things are assisted or actually accomplished by various electromechanical devices, the reliability requirements have tended to increase in number and become more stringent.

Testing

The need for these higher levels of reliability can be shown, and industry is moving rapidly to address them; but, therein lies a dilemma for reliability testers. Testing costs have increased, and constricted development schedules have reduced the time available for testing. Testers find themselves facing late 20th century reliability requirements with early 20th century assessment methodology. Something must give, and invariably with inadequate methodology, it is the testing which gives. This translates to those responses too often heard by the reliability test engineer "There isn't enough time in the development schedule; we can't afford that many test hours (or trials), it is too expensive; we don't have that many to give you just for test." Sometimes the system turns out reasonably reliable when fielded, sometimes not. When it does not, the cost may be high in dollars and worse in lives.

The ability to meaningfully measure the reliability of a complex weapon system and compare it against requirements is lost in the jungle of insufficient test hours and test items and increasingly constricted development schedules. The call to "just do a subjective assessment" and "don't try to compare performance against a number" is increasingly heard. Returning to Lord Kelvin's observations, we find ourselves moving back toward knowledge of reliability that is of a "meager and unsatisfactory kind." This observation is not intended to disparage the usefulness of the non-quantitative aspects of reliability analysis as it relates to the identification of the major causes of poor reliability. It is intended, however, to plead the case against abandoning the pursuit of meaningful quantitative assessment.

It was once said that "there is something in numerals, in the process of calculation, extremely frosty and petrifying to man." The calendar time, number of trials, test hours, and dollars required to realistically assess reliability have, indeed, been frosty and petrifying to the whole process of reliability demonstration.

The Bayesian Approach

What is needed are new analytical tools for the practicing reliability test engineer. Those tools may already be available and only require some shaping and molding to fit our purpose. They are the product of an 18th century Englishman, the Rev. Thomas Bayes, and are appropriately known as Bayesian reliability inferences. Conditional probabilities are involved as well as the use of *a priori* estimates. These *a priori* estimates have usually been engineering judgments that are based on the performance of similar systems. This approach has caused much controversy due to its subjective nature, and the resulting tendency has been to shy away from Bayesian estimates of reliability. However, with increasing emphasis on Army monitoring of contractor development testing, limited government development testing, and first article testing, an opportunity presents itself to possibly use the Bayesian techniques in assessing the higher reliability requirements of current helicopter systems within the constricted test time available.

The *a priori* estimates could be based on the prior test results, eradicating the subjective nature of those estimates. The result could be an analytical procedure that allows us to make full quantitative use of contractor development test results during government development testing and contractor and government development test results during first article testing. In each case, the earlier results could serve as the *a priori* estimate for the following test.

A case to illustrate the potential is taken from the lecture material of the late Dr. Austin J. Bonis, Rochester Institute of Technology, presented at the 10th Annual Reliability Engineering and Management Institute at the University of Arizona in November 1972. The case concerned a hypothetical system which had undergone previous testing. In Dr. Bonis' example, the *a priori* belief was 50 percent that a 95 percent system reliability had been achieved. Failures occurring during earlier testing of the system had been addressed and the best engineering judgment was that the problems had been solved. The question raised was how many trials were required to have 90 percent confidence that the required level of reliability had been achieved.

Classical reliability inference using the binomial distribution would require 45 trials with no failures. This approach essentially assumes that there is no prior quantitative knowledge of the system reliability.

The Bayesian approach, suggested by Dr. Bonis, assumes that there is some prior quantitative knowledge about the system reliability and expresses this as the *a priori* belief that the required reliability has been achieved. Using 50 percent as this *a priori* estimate or belief, Dr. Bonis showed that 13 trials with no failures would be required to have 90 percent Bayesian confidence (posterior probability or belief) that the 95 percent reliability was achieved.

Dr. Bonis distinguished between confidence in a classical sense and Bayesian confidence by saying that "in the classical sense, when we predict that the true reliability is greater that a certain lower confidence limit, we are saying that, in the long run, the probability with which we can make correct statements like this will exceed the confidence level" while in the Bayesian sense, "when we predict the probability that the true reliability is greater than the required reliability, we mean the probability that this particular statement will be right."

The fine distinction I leave to the professional mathematician/statistician. Both, however, are indicators of degree of belief. The advantages of this approach are obvious; fewer trials, less testing hours, and lower cost in dollars and time by taking quantitative advantage of the knowledge we've gained from earlier testing. What are the disadvantages? It obviously puts a premium on sound engineering judgment as to whether incorporated fixes actually solve the problems and preclude the failures experienced earlier in the program. It is clearly obvious that Bayesian assessment techniques won't be appropriate in all cases, but should be of use many times to the practicing reliability test engineer.

Now I realize that the mere mention of Bayesian approaches to reliability inference is likely to stir the winds of controversy. However, these approaches could offer a powerful tool for reliability analysis. Chapter 16 of Army Materiel Command Pamphlet 706-200 cautions the reader on the dangers of misuse of the Bayesian techniques. Rather than be afraid of their misuse, however, the challenge is to develop handbook techniques that will facilitate correct application.

Dr. Bonis' paper on Bayesian Reliability Demonstration Plans in the Reliability and Maintainability (RAM) Annals of the American Institute of Aeronautics and Astronautics' Fifth R&M Conference in July 1966 may be of interest in this respect. These Bayesian approaches offer the possibility of saving not only time and money . . . but perhaps saving reliability demonstration from an early death by providing a means to measure and express reliability quantitatively in a more timely and cost-effective fashion.

This has obviously not been an effort to present the case for Bayesian reliability inferences in a rigorous mathematical fashion, but has been an effort to challenge knowledgeable professionals to look more closely at this potentially useful tool.

Statisticians! Mathematicians! Analysts! Are you listening out there?

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The Emergence of Inorganic Polymers

Our society depends on high technology materials. The Army, in particular, has especially severe needs for advanced materials. Among the Army's needs are strong, flexible materials that are resistant to heat, cold, chemical attack, abrasion, and other degrading processes present on the battlefield. These strong, flexible materials are needed for O-rings, gaskets, fuel lines, hydraulic system and shock absorber components, gas masks, storage containers and for many other uses. The group of materials used now for these purposes is polymers.

Polymers

Polymers are very large molecules forming the basis of plastics, elastomers, fibers, paints, films, etc. They are used throughout the military and civilian communities and have contributed immensely to the high quality materials of high technological value in existence today.

With few exceptions, almost all polymers are organic—based upon the element carbon, and are derived principally from petrochemicals. Almost all polymers are organic because organic polymers are relatively easy to make. Organic polymers are most often prepared from small organic molecules called monomers which are widely available from the petrochemical industry and have been thoroughly studied over the last century by organic chemists. There are many well understood chemical reactions (synthesis routes) for linking the monomers together into polymers. By linking different monomers together in different ways, chemists have produced many different polymers with many different properties.

The science of organic polymers is so well understood that compounds can be tailor-made for desired properties. But there are limits to this approach because the properties of the polymer still depend on those of the monomer of which it is made. Organic molecules have, for example, limited thermal stability. Some inorganic molecules, however, have high thermal stability and other properties that would be desirable in a polymer.

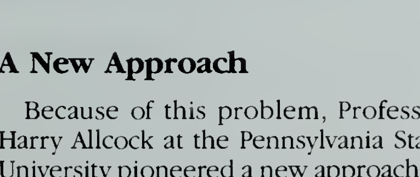
In principle, elements other than carbon could be incorporated into the backbone of a polymer to impart different characteristics and new opportunities for the design of useful, new materials. There are, however, a number of reasons why efforts to make an inorganic polymer have rarely succeeded. In organic polymer chemistry, there are well known polymerization routes for converting the organic monomer into the polymer. The application of these principal polymerization routes, so successful for organic polymers, has not met with the same success in making inorganic polymers. The main reason is the inherent chemical differences between inorganic and organic monomer molecules.

A New Approach

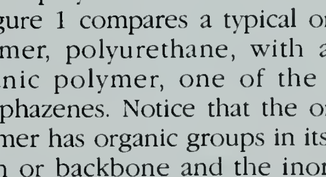
Because of this problem, Professor Harry Allcock at the Pennsylvania State University pioneered a new approach to inorganic polymer synthesis. He and his research group made polymers containing a backbone of alternating phosphorus and nitrogen atoms with two reactive side groups attached to phosphorus (usually chlorine). Replacement of these reactive side groups by substitution reactions permits preparation of a wide variety of different macromolecules with many different properties. Support for this research has been provided by the Army Research Office. A great deal of complementary effort has taken place at the Army Materials and Mechanics Research Center.

These new polymers are called polyphosphazenes and they are high molecular weight, linear polymers with alternating phosphorus and nitrogen atoms in the skeleton and two side groups attached to the phosphorus. Depending on the type of side groups present, the polymers may be flexible, film or fiber forming materials or elastomers. Allcock's synthesis procedure has the ability to change the properties of the polymer by changing the side groups. Some side groups create solvent resistance. Most also resist burning or oxidation break-down far better than simple organic polymers.

Figure 1 compares a typical organic polymer, polyurethane, with an inorganic polymer, one of the polyphosphazenes. Notice that the organic polymer has organic groups in its main chain or backbone and the inorganic polymer does not. This difference in structure leads to great differences in properties. For example, both can be used in foam materials, but in a fire, polyurethane burns and emits copious toxic fumes while polyphosphazene is



Organic Polymer:
Polyurethane



Inorganic Polymer:
Polyphosphazene

Figure 1. Comparison of typical organic and inorganic polymers. R and R' are organic groups. The "( )n" means that n of the molecules shown are linked to form the polymer.

self-extinguishing in air and emits only small amounts of combustion products.

Multipurpose Applications

Some of the desirable properties of polyphosphazenes include high stability to water, solvent and fuel resistance, flexibility at low temperatures, and biostability and biocompatibility. Some uses already found for these polymers include O-rings, gaskets, fuel lines, hydraulic system and shock absorber components, and non-burning insulating materials. Figure 2 shows current and proposed uses for polyphosphazenes and their performance properties. For example, the properties that make polyphosphazenes useful in the M1 tank plenum seals are shown explicitly by the connecting lines.

These new polymers are exceptionally versatile. For example, drugs may be attached to the polymeric backbone and, with proper design, the polymer can be made to release the drug slowly into the system. Polyphosphazenes may also serve as carrier polymers for transition metal catalysts.

Small scale production of polyphosphazenes has been expensive, but commercialization of polyphosphazenes on a large scale has begun at the Ethyl Corp. As scientists understand the polymerization process better and develop new methods, polyphosphazenes will cost less and can be expected to receive increased military application. Support of basic research by the Army in synthetic inorganic chemistry has played a significant role in the history of these useful, new materials.

Uses and Performance Properties of Polyphosphazene Elastomers

Uses	Performance Properties
Aircraft fuel control systems	Broad service temperature range: hot tear strength, low temperature flexibility
*Air plenum seals for M-1 tanks	Dynamic sealing applications
Arctic fuel hoses, couplings and gaskets	Excellent flexural fatigue
*Jet engine isolation mounts	Vibration damping
Military aircraft hydraulic systems	Toughness, abrasion resistance
Military hydraulic fluids	Hydrocarbon fuel and fluid resistance
O-rings, seals, diaphragms	Low compression set
*Pipeline surge suppressors metal bonding	Fire, fungus, ozone, and weather resistance

(The connecting lines show the properties that make polyphosphazenes useful in the M-1 tank plenum seals.)

***Applications now in production.**

Figure 2.

The preceding article was authored by Dr. Bernard F. Spielvogel acting associate director of the Chemical and Biological Sciences Division, U.S. Army Research Office (ARO), Research Triangle Park, NC, and Dr. Robert W. Shaw, chief of physical and analytical chemistry, Chemical and Biological Sciences Division, ARO.

The Acquisition Process

(Continued from inside back cover.)

must be in place. Repair parts must be rolling off the production line or else we shouldn't field the system.

Can we pull off a streamlined development cycle? General Thompson thinks so. If we do it together and do it right, it can be done. Doing it right may take a little longer in the initial stages of a program, but the harsh lesson we have learned over the years is that cutting corners just carries the problems into the future and eventually to the soldier.

We cannot tolerate shoddy workmanship, incomplete design or less than adequate documentation. We must build in supportability, think readiness, pull together and get meaningful, cost effective technology to the field sooner. The goals of high quality materiel and rapid fielding are not incompatible but to achieve them both require a special effort from all of us in the RDA community. There will be no more "business as usual" in materiel acquisition. We cannot successfully streamline the acquisition process and rapidly integrate new technologies into our materiel systems without a widespread, grassroots effort to do it right.

NBC Collective Protection

By William K. Blewett

In 1928, the U.S. Army completed a detailed study of the chemical casualties of World War I. The statistics showed that one widely used means of chemical defense, the gas-proof shelter, was remarkably ineffective: 24 percent of the 7,000 U.S. mustard gas casualties occurred in such shelters.

Now, more than six decades after the first and only battlefield employment of gas-proof or collective-protection shelters, the U.S. Army is on the threshold of a new era in chemical defense. Tens of thousands of collective protection systems will be issued to field troops during the next few years.

The XM20 Simplified Collective Protection Equipment, nicknamed the Big Baggie (Figure 1), will be fielded in 1987. The M1A1 Abrams tank, equipped with a new positive-pressure air-filtration system, goes to the field in 1986. Also, thousands of systems for command, control, communications, and intelligence will soon be fielded in mobile, rigid-wall shelters equipped with modular collective protection equipment (Figure 2).

These, like all collective protection systems, contain a charcoal filter, similar to the one shown in Figure 3, to supply the shelter or crew compartment with a large volume of purified air at slightly elevated pressure. They create a clean-air environment in which soldiers can work without wearing masks or other chemical-protective gear.

The new systems are vastly superior to the gas-proofing equipment used in World War I. They have a far greater protective capability and are much simpler to deploy and operate. They are key elements in the effort to overcome what has been described by Under Secretary of the Army James Ambrose as "the Army's most severe vulnerability": chemical-biological warfare.

The effectiveness of collective protection hardware has been well proven by intensive testing, but the other elements of the total system—doctrine and training—are of tremendous importance. There is perhaps no defensive system for which doctrine and training have greater impact than nuclear, biological and chemical (NBC) collective protection.

> "They were supposed to be gas proof. . . . The majority, however, were gas traps, rendered so in many cases by the entrance of men whose clothing was saturated with gas fumes."—COL H. L. Gilchrist, Chemical Corps, 1928.

Now, as in World War I, there is no technology which allows us to scrub contamination from the clothing, skin, or hair of soldiers quickly before they enter a collective protection shelter. Carrying contamination into a shelter can presently be prevented only by using doctrine known as entry/exit procedures.

The U.S. Army Chemical Research and Development Center (CRDC) has worked closely with the Army Training and Doctrine Command to develop the most effective entry/exit procedures for all collective protection systems, whether they be vans, vehicles, or shelters. These procedures involve precisely ordered steps of detection, decontamination, and doffing of the chemical ensemble to prevent even trace amounts of agent from entering the shelter.

The procedures are slow. It takes a soldier 15 minutes to process into the XM20 Simplified Collective Protection Equipment. To exit and re-enter the M1A1 tank in a contaminated environment takes a total of 25 minutes. Similar procedures developed by the Air Force for underground shelters require 25 to 30 minutes per entry.

Tests at CRDC have identified the ways contamination is most readily transferred into a shelter. Small drops of agent on the surface of the chemical overgarment, boots, gloves, or hood can be transferred to the fatigues or skin when this equipment is removed just prior to

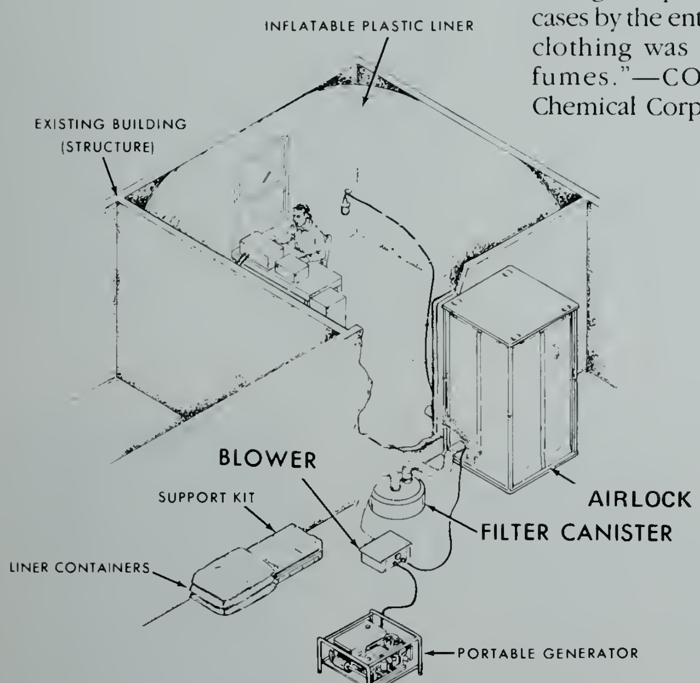


Figure 1. The XM20 Simplified Collective Protection Equipment.

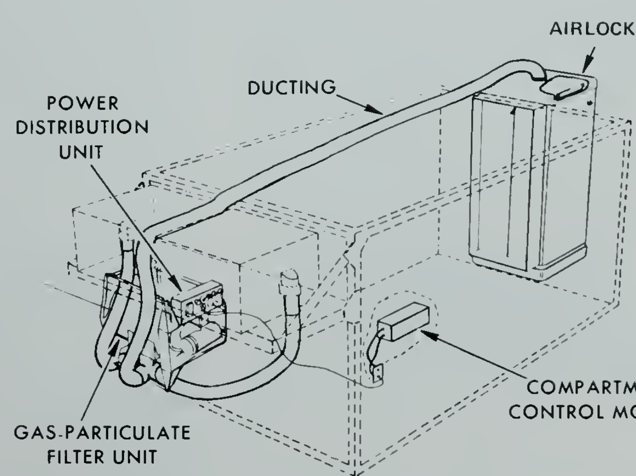


Figure 2. Modular Collective Protection Equipment.

entry. The fatigues of the soldier can also absorb toxic vapors from the air during the brief period between removing the overgarment and entering the shelter. Airborne contamination can also be wafted directly into the shelter through hatches or door openings during entry/exit.

This last mechanism of transfer is prevented by an airlock, a small vestibule through which clean air is vented. The airlock is a component on all collective protection systems, except those on vehicles like the Abrams tank. An airlock works no magic. It merely flushes contaminated air by diluting it with clean air. The five-minute "air washing" period in an airlock has virtually no effect upon contamination carried on garments or equipment. Now, as in World War I, if a soldier enters in clothing "saturated with gas fumes," casualties can result.

Today's entry/exit procedures are designed for safe entry in what could be described as worst-case contamination conditions. Their effectiveness has been demonstrated in testing with simulated chemical agents involving volunteer test subjects. However, we still do not know if they will work on the battlefield. Perhaps the real question is: Will training and discipline in their use be adequate?

> "Many men were gassed in an old barn in the midst of the gassed area. The men entered, removed their masks and laid down on the gas-saturated hay. . . . The odor of (mustard) gas was very strong at the time, but inasmuch as their officers were present without masks, they thought the place safe."—COL H. L. Gilchrist, 1928.

The archives are rife with examples such as these in which lack of training or discipline resulted in chemical casualties. Because chemical and biological weapons are silent and virtually invisible, it is difficult for troops to comprehend the actual threat, and to avoid lapses in defense against that threat. Fatigue and stress can also cloud perceptions of danger.

The problem of "gas discipline" was a major one in 1918, as this excerpt from a G-3 memo of the 90th Infantry Division indicates:

> "Examination of the (1,100) gas casualties show that at least 80 percent were inexcusable . . . due to flagrant breaches of gas discipline. Henceforth, all men evacuated as gas casualties will be tried by summary court martial for neglect of duty when the nature of the casualty indicates . . . a breach of gas discipline."

A training program on entry/exit procedures is currently being developed by the U.S. Army Chemical School. When this program is available, units will perform periodic training in these procedures.

Beyond this training, however, emphasis must be placed on developing an understanding of the principles of chemical-biological defense. A sound knowledge of the threat is very important. Without it, the weapons become more formidable. They assume an aura of omnipotence.

> "One whiff of the stuff, one drop on the skin, and you're dead."—An anonymous soldier.

The quote exemplifies the attitude of hysteria associated with chemical-biological weapons. They are extremely powerful, but the mythology of their power fails to consider the uncertainties of wind and weather which make on-target delivery difficult, particularly against protected troops.

> "One soldier in panic shouted 'gas', and the entire First Infantry Division on (Omaha) beach was thrown into disorder. For three hours, order could not be restored. At no point was gas actually used. But in one of the most extraordinary events in military history, the very idea of gas froze a crack, battle-hardened division in the midst of a crucial invasion."— the book *Yellow Rain,* Sterling Seagrave, 1981.

The psychological impact, perhaps the greatest effect of chemical weapons, is demonstrated by this experience during the invasion of Normandy. It is the tremendous loss in tactical efficiency, through psychological effects or the indirect physiological effects of heat stress, which makes chemical warfare so attractive to our potential enemies.

These problems too must be addressed in employing new collective protection systems. Will troops doff protective clothing they know to be contaminated with toxic agent or will they show the same apathy which caused casualties in World War I? Will they be capable of performing procedures properly under battlefield stress after long periods of wearing the mask and overgarment? Only through a thorough understanding of chemical threat, regular training, and disciplined use of sound doctrine can the answer to these questions be favorable.

While the concept of collective protection is a simple one, employing it effectively is far less simple. This presents a great challenge. Improved hardware—automatic detectors, better individual protection equipment, new decontaminants, and more efficient filtration units—are in development. These will make employment of collective protection safer and less burdensome, but they will not decrease the importance of sound doctrine, training, and discipline in chemical defense.

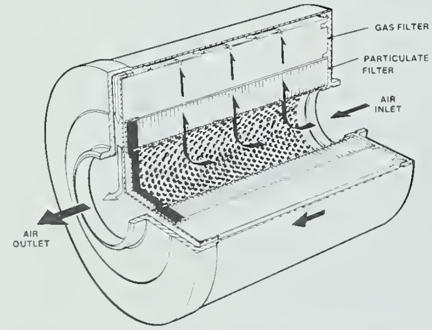
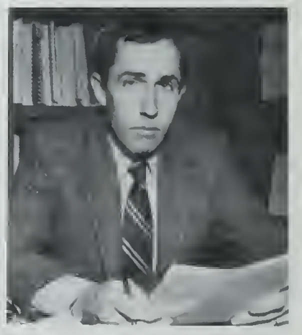


Figure 3. M48 Gas-particulate filter.

WILLIAM K. BLEWETT is a mechanical engineer in the Physical Protection Directorate of the U.S. Army Chemical Research and Development Center (CRDC). During his 11 years at CRDC, he has worked as producibility engineer for the M51 shelter system, development engineer for the XM20 Simplified Collective Protection Equipment, and principal investigator in the CRDC Entry/Exit Program. He holds a B.S. degree from the University of Oklahoma and an M.S. degree from Texas A&M University.



Army M76 Smoke Grenade Ready for Production

By Randal H. Loiland

The advantage of using smoke in combat has been known for centuries. Early smoke screens and signals were achieved by using natural materials such as straw or grass. World War I saw the use of preplanned smoke come to the forefront of the battle in the form of smoke pots and munitions.

In recent years, the Army has equipped virtually all front line combat vehicles with a defensive smoke screening system. This system provides armored vehicle commanders with the capability of creating a nearly instantaneous smoke screen between himself and a threat force. The screen will last for one to three minutes, allowing the commander time to escape from an unfavorable situation. The heart of this defensive system is the L8 red phosphorus smoke grenade fired in salvo from eight- or 12-tube smoke grenade launchers.

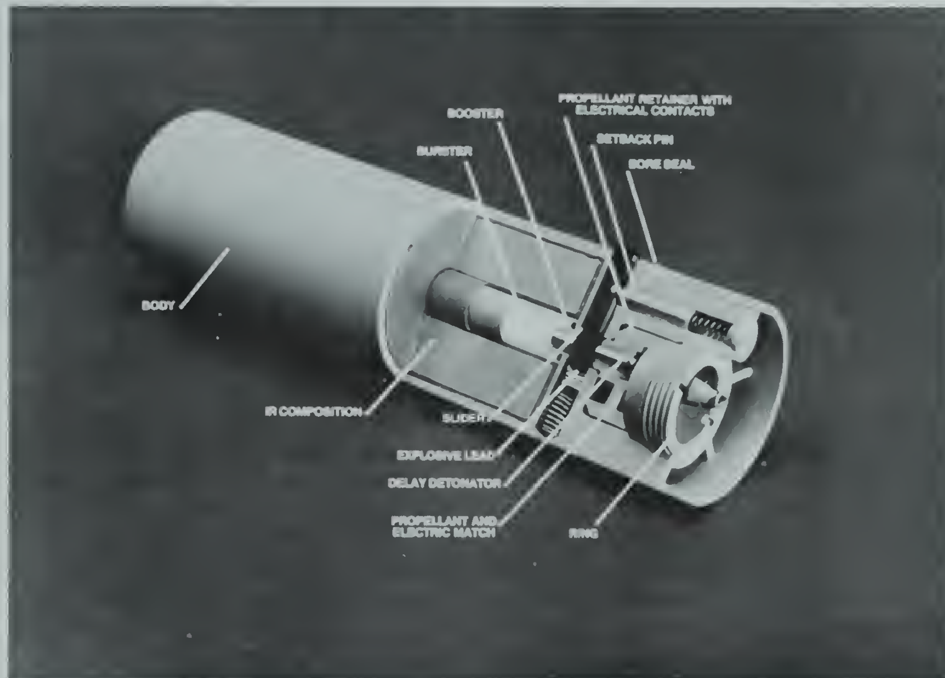


Figure 1. GRENADE, LAUNCHER, SMOKE IR SCREENING XM76

Type Classification

The L8 grenade is an extremely effective, visible and near infrared screening device but has minimal effect on threat weapons operating in the mid- or far-infrared regions of the electromagnetic spectrum. To counter the latter weapons, the Army Office of the Project Manager for Smoke/Obscurants (PM Smoke) at Aberdeen Proving Ground, MD, initiated development of the M76 grenade for use on the M1 Abrams tank. This development culminated with the Army type classifying the M76, the first munition designed to defeat (for 45 seconds) threat weapon sensors operating in the visual through far-infrared regions of the electromagnetic spectrum.

The M76 grenade is capable of being launched from the M239, M243, M250, M257, or M259 smoke grenade launchers which are mounted on virtually all armored vehicles in the U.S. military inventory (e.g. the M2, M3, Improved TOW Vehicle, Fire Support Team Vehicle, M88, M60A1/A3, M113, and SGT York).

The M76 grenade is 2.61 inches in diameter, 9.38 inches long and weighs approximately four pounds. The grenade is electrically initiated, propellant launched, and explosively disseminates a screening cloud approximately 30 meters forward of the Abrams tank.

Components and Design

The grenade consists of a plastic body which houses the grenade launch system, a safe and arm mechanism that allows detonation only when the grenade has been launched, and smoke composition (Figure 1). The grenade launch system is made up of electrical contacts and an electric match mounted on a propellant. When the grenade is fired, propellant pressure is vented behind the grenade through a thin rupture disc in the propellant retainer.

The safe and arm mechanism is designed to interrupt the delay detonator, transfer lead, booster and burster explosive train by positioning the transfer lead safely out of line until the grenade functions. This transfer lead is mounted in a spring-loaded aluminum slider. The pyrotechnic time delay is contained in an aluminum housing while the booster and the composition A5 burster are housed in plastic. The slider assembly is moved farther out of line when the grenade is inserted in the launcher tubes which simultaneously unlocks the setback pin.

When the grenade is launched, the propellant initiates the time delay and launch acceleration causes the setback pin to move rearward, disengaging the slider. At muzzle exit, the slider moves the transfer lead into alignment with the explosive train. The delay initiates the detonator-transfer lead-booster-burster train at the prescribed range, disseminating the smoke composition into an aerosol cloud.

This design provides maximum safety and achieved functional reliability of well over 99 percent during development testing at Dugway Proving Ground, UT.

The AAI Corp. in Cockeysville, MD, was the prime contractor during engineering development of the M76. The

Army Chemical Research and Development Center, also headquartered at Aberdeen Proving Ground, provided PM Smoke with the necessary engineering support. This team of experts developed a truly remarkable smoke grenade.

The development program was initiated in September 1979 and, based on promising results early in the program, the M76 project was accelerated at a special program review in March 1982. The original development schedule dictated a six year program, but the accelerated program shortened this time by one year.

This compressed schedule was achieved by increased contractor efforts prior to the Validation In-Process Review (milestone II) and by combining the development and operational testing at Dugway Proving Ground. Figure 2 depicts an M1 Abrams tank maneuvering behind a smoke screen during the operational phase of this test.

Figure 2. An M1 Abrams tank maneuvering behind a smoke screen.

Technical problems associated with the fuze delay element during testing at Dugway Proving Ground jeopardized Army efforts to accelerate the program. However, outstanding response from the contractor minimized the time required to correct the problems. In addition, Dugway Proving Ground accelerated test efforts while maintaining the required test methodology to provide decision makers with necessary data. The Army Test and Evaluation Command and the Army Training and Doctrine Command provided technical assessments necessary for a production decision internal program review, one month after completion of testing. These efforts helped to limit the production decision slippage to six months, thus allowing the M76 development program to be completed in 5 1/2 years. A production contract was awarded in May 1985.

New material release of the grenade is presently scheduled for March 1986, just 12 months after type classification. It is this kind of expeditious scheduling and outstanding Army and contractor team effort that will provide the soldiers in the field with the necessary equipment in a timely manner to effectively accomplish their mission.

International Testing

Extensive international testing has also been accomplished during the development program. The M76 grenade was entered as a candidate armored vehicle protection system into NATO visual through far-infrared screening smoke trials conducted in France and Norway in September 1981 and January 1982, respectively. These trials provided summer and winter test results on the various candidate systems.

England, Australia and Canada have considered procurement of the M76 grenade for their armies. Their interest led to field testing in England during July 1983 and in Canada during February 1985. Australian trials are scheduled for October 1985.

The net result of this foreign interest is that the M76 has been tested in a number of different climatic conditions and is performing as designed. These trials have also generated considerable foreign military sales potential while allowing the United States to evaluate foreign technologies and continually assess its own progress on a worldwide scale.

Since the launcher technology used to fire the M76 grenade was procured from the United Kingdom, it has made the grenade compatible with all present United Kingdom launchers. This grenade/launcher compatibility also impacts countries such as Canada, Australia, Greece, Netherlands, Brazil, and third world countries which have procured U.S. or United Kingdom developed smoke grenade launchers during the past few years. This interoperability will provide NATO allies with an enhanced posture in carrying out their intended military defensive mission.

RANDAL H. LOILAND, a general engineer, is a project manager in the Army Office of the Project Manager for Smoke/Obscurants at Aberdeen Proving Ground, MD. He has a bachelor's degree in mechanical engineering from the University of North Dakota, a master's degree in industrial engineering from Texas A&M University, and is a graduate of the Army Industrial Engineer Intern Training Program.

Improved Fire Protection for M60 Tanks

The R&D Center of the U.S. Army Tank-Automotive Command (TACOM) is developing an add-on automatic fire-extinguishing kit for the M60A3 tank that can extinguish explosive hydrocarbon fuel and oil fires within a quarter of a second after ignition. The equipment is already in use in the M992 Field Artillery Ammunition Supply Vehicle (FAASV), and similar equipment is being used in the M1 tank and M2/M3 Bradley Fighting Vehicles.

M60s currently use manual fire-fighting equipment. In the hull, this consists of three steel bottles of pressurized carbon dioxide that are used to put out engine-compartment fires. When a fire occurs, the driver discharges the CO_2 by pulling a lever bottle for the first fire extinguishment. In the event of another fire, the remaining two bottles are discharged simultaneously. For turret fires, the crew uses a hand-held CO_2 unit. The manual system is effective in extinguishing slow-growth fires. However, human response time is not quick enough for the system to be activated in time to extinguish explosive fires.

A frequent cause of explosive fires in combat vehicles is penetration of the fuel tank by a fired projectile. Ignition of the fuel usually occurs at precisely the moment when the projectile breaks through the exit wall of the fuel tank, and produces a small fireball several inches in diameter. This fireball expands rapidly, and requires only about a quarter of a second to become large enough to produce the high internal vehicle pressures that always accompany hydrocarbon fuel fires.

In field tests, the new automatic equipment has consistently demonstrated the ability to arrest diesel-fuel fires within a quarter of a second—in time to prevent a fire from reaching catastrophic proportions. It consists of an optical fire-detection subsystem and a fixed fire-extinguisher subsystem. The fire-detection portion includes sensors designed to detect optical radiation, which is always present in a fire. Also included is an electronic control unit that activates the system.

The fire-suppression subsystem consists of bottles of an improved fire extinguishant called Halon 1301. This is a substance belonging to a large family of gases and liquids known as Halon, which is a contraction of the words halogenated hydrocarbons. Halon 1301 is safe to breathe for up to five minutes at the low concentration levels required to extinguish fires. This is not the case for CO_2. Each bottle is equipped with a fast-acting, electrically-actuated valve used to release the Halon 1301.

The M60A3 will have two systems—one in the hull and one in the turret. The hull system will include four sensors to protect the engine compartment and nearby fuel tanks. It will also have two fire-extinguisher bottles. The turret system will have three sensors and four fire-extinguisher bottles. Each system will have its own electronic control amplifier unit.

In operation, the sensors of each system will pick up optical radiation emissions the instant a fire starts and feed the signals into the control amplifier unit. Then, after electronically processing the signals and establishing that a fire does exist, the unit will electrically open the valves to release the fire extinguishant.

In the turret, the control unit will discharge two bottles, and, if the fire continues to burn, will automatically discharge the remaining two bottles. In a hull fire, the control unit will only discharge one of the two bottles automatically. The second bottle, if required, must be activated manually.

If either system should fail to respond to a fire, manual controls will allow the crew to activate the systems from inside or outside the vehicle. Each system also will include a test and alarm panel to permit the crew to check all electric circuits, as well as the state-of-charge of the bottles. The systems will be able to distinguish between hydrocarbon fires and non-fire signals such as flashlights, vehicle headlights, sunlight, gunfire flashes and burning matches. Even if a high-explosive shaped charge or kinetic energy projectile should pass through the vehicle, as long as it did not start a fire, the optical sensors would not activate either system.

In addition to protecting against explosive fires, the systems will respond to slow-growth fires such as those caused by electrical short circuits.

The program to develop the M60A3 fire-extinguishing kit is a total TACOM in-house effort that began in June 1983. In progress made to date, the Systems Laboratory and the Engineering Support Directorate of TACOM's R&D Center have prepared automatic fire-extinguishing system purchase descriptions needed for making preliminary buys of system hardware. These documents were based on the performance of system components in earlier field tests, and will become the military specifications for the M60A3 fire-extinguishing kit upon completion of its development.

The R&D Center-developed extinguishing components are designed to performance-oriented purchase descriptions, defining form, fit and function. However, they do not dictate how a given manufacturer will design internal systems. Thus, extinguishing components purchased in accordance with purchase descriptions will be interchangeable among manufacturers. Combat vehicles such as the FAASV, M60A3, and the M109 Howitzer Extended Life Program and future vehicle systems will be able to order from a common family of interchangeable components supplied by a number of sources.

The Engineering Support Directorate has completed efforts to determine the most suitable locations for the system components within the M60A3 and designed brackets needed to mount them. Additionally, the directorate fabricated prototype systems which were used for trial installation into an M60A3 vehicle at TACOM. The vehicle underwent extensive laboratory tests prior to the start of the Aberdeen tests. All testing was completed by the end of summer, and TACOM will soon release a technical data package for procurement of the required retrofit kits in FY86. The M60A3 retrofit is scheduled to begin in FY87.

The preceding article was authored by George Taylor III, a technical writer-editor for the Army Tank-Automotive Command, Warren, MI.

From The Field. . .

New Computer Improves Battery Testing

A new computer system installed recently at the Army Communications-Electronics Command's Product Assurance and Test Directorate Battery Test Facility is expected to test and evaluate more than 40,000 batteries this fiscal year.

Anthony Constantine, acting chief of the Test, Measurement and Diagnostic Equipment Engineering Branch, said results indicate that a savings of about $88,460 annually will be achieved. In addition to the cost savings, the new system has greatly increased test flexibility, reliability and overall response time, Constantine added.

The project was funded as a Productivity Capital Investment Project under the Productivity Improvement Program at a cost of $258,000. Payback will occur within three years. The computer is programmed to take information from 17,280 battery test circuits and within microseconds evaluate and compare the data to specification requirements stored in memory.

The system can test all current battery types and produces a report for each battery tested.

A government quality assurance representative selects a sampling of batteries from the contractors' monthly production lot. These batteries are taken to the Battery Test Facility, one of the largest automated battery-testing facilities in the world, for conditioning, discharge-capacity testing and post-shipment evaluation.

The batteries are stored under various environmental conditions and then tested for performance. They also are tested for load/discharge conditions which simulate the use of each battery type in the equipment for which it is intended.

The tests this fiscal year will determine the quality of more than $100 million worth of batteries for the Communications-Electronics Command.

Army Awards Contract for Imaging Radar

The Strategic Defense Initiative Organization and the Army's Ballistic Missile Defense Organization (now the Strategic Defense Organization) have announced the award of contracts to two companies to develop competing preliminary designs for a ground-based Terminal Imaging Radar (TIR).

The six-month contracts, for approximately $5 million each, have been awarded to Raytheon Co. Wayland, MA, and Westinghouse Electric Corp., Baltimore, MD.

The purpose of the TIR program is to develop technology for a ground-based, phased-array radar that can discriminate between re-entry vehicles and the many other objects re-entering the earth's atmosphere during an attack. The radar is being developed and will be field-tested in compliance with all U.S. treaty obligations including the 1972 Anti-ballistic Missile Treaty.

The two contracts are for the first phase of a planned three-phase program leading to an experimental validation of the TIR technology.

In the first phase, the contractors will develop a preliminary design for the TIR. The contracts include an option for a 12-month second phase. If the option is exercised, the Army would select one or both of the contractors to refine their preliminary design to assure that it can meet the technical requirements for the radar. The second phase would also include development of a proposal for the third phase of the program fabrication and technology validation of the TIR at Kwajalein Missile Range.

The major subcontractor for the Raytheon effort is TRW Defense Systems Group, Redondo Beach, CA. Subcontractors to Westinghouse are Computer Sciences Corp., Moorestown, NJ; Delta Research Inc., Huntsville, AL; Nichols Research Corp., Huntsville AL; and XonTech, Inc., Van Nuys, CA.

The TIR program is the second major Strategic Defense Initiative sensor technology effort the Army has put under contract. A contract for the Airborne Optical Adjunct, which will examine how airborne optical sensors can be used to augment ground-based ballistic missile defense radars, was awarded a year ago.

VE Proposal Will Improve M1 Reliability

Reliability of the M1 Abrams tank will be increased significantly thanks to a value engineering proposal (VEP) initiated by two U.S. Army Armament, Munitions and Chemical Command (AMCCOM) engineers. Not only will the readiness of the Army's main battle tank be improved, but a savings of $23 million over three years will be achieved.

Marv Huizinga was the manager of an engineering team responsible for quality control on the M1 tank's fire control and gun system. Kent Schmitz was a key member of the team. Soon after the system was fielded these two individuals noticed a tremendous amount of failures on the tank's thermal imaging system, a night vision apparatus, and the laser range finder.

The two engineers attributed the failures to flaws in the electronic components. After taking a critical look at the problem, Huizinga and Schmitz proposed that the environmental stress screening now being used to test the electronic components be improved.

Environmental stress screening is a new technique that improves the quality and reliability performance and reduces manufacturing and support costs. The technique puts electronic parts through a series of hot and cold cycles and then shakes the items at different rates in a vibration test.

The two quality assurance tests detect 95 percent of the faulty parts. Hidden flaws introduced into electronic hardware by defective assembly processes and workmanship problems are forced into failures that are easily detected by the improved inspection techniques.

"We discovered the stress screens used by the contractor were not tough enough and too many failures were occurring," says Huizinga. Schmitz and Huizinga felt the stress screening was not being used to its full potential.

"Prior to the VEP, stress screening involved 20 cycles of taking the parts from minus 40 to 149 degrees Fahrenheit and then sending the parts through a routine vibration," explains Schmitz. "The value engineering study we performed calls for 30 cycles that range from minus 65 to 203 Fahrenheit and then varying the rate of the vibration screen.

"The environmental screens stress the electronic parts beyond their normal operation," points out Schmitz. "About 95 percent of the parts that are going to fail do so early, resulting in much cheaper replacement costs. Generally most electronic parts have a 40-year life."

The value engineering proposal will significantly reduce repair failure costs at the M1 production plants where the tank

is assembled and at field locations where the various units are operating with the Abrams. The value engineering study determined that by making the stress screens more efficient, the effectiveness of the tank's fire control screening procedures could be upgraded from 64 to 95 percent.

AMCCOM's quality assurance officials base the three year savings of $23 million on a reduction in repair costs and a reduction in the number of spare parts required to maintain the system. Repair costs are figured by catching the faulty systems closer to the electronics production lines. The cost to replace a faulty circuit card is estimated at $50. When the cards are assembled to form a unit, the repair cost is $250. The repair costs increase up to the point where it costs $9,071 to replace a faulty electronic part on the fire control system for an M1 tank in the field.

With the improved environmental stress screen, we can catch 95 percent of the faulty parts in the contractor's plant at the circuit card level where the cost is $50, says Schmitz.

Further applications are planned for use of the improved environmental stress screens. The quality assurance people are looking into using the screening system on the Bradley Infantry Fighting Vehicles, the SGT York Division Air Defense System, and the spare parts on the M60 tank. The new applications can result in a cost avoidance of $46 million on the fire control systems.

Health Hazards Office Studies Risks

To counter the obvious risks associated with being a soldier and using weapons, the Army is constantly looking for ways to decrease the hazards of perhaps the most dangerous of professions.

One of the better ways to reduce those hazards is by insuring trained occupational health specialists become involved in the development and acquisition process of new weapons, materiel systems, clothing and equipment, according to CPT Scott E. Rowden, chief of the Health Hazards Assessment Office at Aberdeen Proving Ground, MD. The office, established in 1983, is an integral part of the U.S. Army Environmental Hygiene Agency (AEHA), headquartered in the Edgewood area of APG.

"The Surgeon General of the Army has been responsible for identifying potential health hazards of new systems. However, a formal program did not exist until 1983," Rowden said.

The main objectives of the Army-wide Health Hazard Assessment Program are to identify and to eliminate or control potential health hazards early in the development of new items.

"This program is essentially preventive medicine for the soldier," said CPT Roger G. McIntosh, physician coordinator at the AEHA. "Industrial workplaces are very controlled environments. It's relatively easy to see and correct potential health hazards. A soldier's environment is not as easy to assess."

Field conditions and combat requirements make the soldier's environment impossible to control, according to McIntosh. "We must try instead to control the piece of equipment or the system the soldier is working with," he said. "If we become involved early enough in the development phases, we can 'design-out,' or reduce some of the potential hazards associated with using military equipment. Our ability to eliminate these hazards depends on how early we get involved in the process."

The Health Hazard Assessment Program is as intricate as the acquisition process itself. A number of organizations are involved, including the Army Materiel Command, the Medical Research and Development Command, the Health Services Command, and the Training and Doctrine Command.

Pulling all the pieces together is no easy accomplishment, but a new Army regulation has eased the process by spelling out just when and how health hazard specialists become involved. The regulation, AR 40-10, calls for health hazard assessments from concept exploration through full-scale development, acquisition and deployment of the system.

Throughout this process, potential health hazards can be addressed and either eliminated or controlled. "Intimate involvement with new system program managers is often needed to insure understanding of the Health Hazard Assessment Program and the potential health hazards associated with a particular system or item," Rowden said.

A major part of the program focuses on health hazard assessment reports, most of which are prepared at AEHA. The reports contain three major types of recommendations: system modification, personal protective equipment and administrative controls.

"Some health hazards cannot be designed out of a system," McIntosh said. "One example is noise. Large weapon systems necessarily generate high levels of impulse noise, which can impair hearing. There's no way around that. So, we must require hearing protection, a form of personal protective equipment."

Some impulse noises can still be hazardous, even with hearing protection. That's when administrative controls are necessary. "The report can recommend that administrative controls be initiated during training, such as limitations on the

A cloud of hydrogen chloride is released during the firing of the Multiple Launch Rocket System. As a result of an AEHA Health Hazard Assessment Report, the door seals on the cab have been improved, which better protects the soldiers inside.

number of rounds fired within a certain time limit," McIntosh said. As an example, administrative controls have been recommended for the shoulder-launched, disposable AT4 Anti-armor Weapon System.

"Because of the fairly high noise levels, limits were placed on the number of rounds fired by a soldier from each firing position," Rowden said. Firing positions included standing, kneeling, lying prone, and firing from a foxhole.

As a result of a Health Hazard Assessment Report, the cab seals on the Multiple Launch Rocket System have been modified to provide better sealing. "When a rocket is fired, a cloud of hydrogen chloride, a respiratory irritant, is released," Rowden said. "The coughing and other symptoms that could result from inhalation of hydrogen chloride would decrease performance levels. The improved seals eliminated that possibility."

"The battlefield can't be safe, but we are certainly trying to make training safe," according to McIntosh.

"We don't want equipment that may increase the chances of a soldier injury or decreased performance on the battlefield," Rowden said. "We in the Army Medical Department can eliminate a lot of those possibilities by becoming involved early in the materiel acquisition process."

Capsules. . .

DA Renames BMD Organization

The Department of the Army has announced that the U.S. Army Ballistic Missile Defense Organization has been redesignated as the U.S. Army Strategic Defense Command. The name change became effective on July 1, 1985. The mission of the command will be focused principally on research in support of the Strategic Defense Initiative.

The Strategic Defense Command remains a field operating agency of the Department of the Army with its headquarters in Arlington, VA. Other elements of the command are in Huntsville, AL, and Kwajalein, Marshall Islands.

LTG John F. Wall commands the Strategic Defense Command. For additional information contact LTC Craig MacNab, (202)697-7589.

Army Aviation Research Lab Changes Name

The U.S. Army Research and Technology Laboratories-AVSCOM, NASA Ames Research Center, Moffett Field, CA, has been renamed the U.S. Army Aviation Research and Technology Activity (ARTA).

Four subordinate research units of the activity have also undergone a name change. They are the Aeroflightdynamics Directorate, formerly the Aeromechanics Laboratory, also located at NASA Ames; the Propulsion Directorate, formerly the Propulsion Laboratory, NASA Lewis Research Center, Cleveland, OH; the Aerostructures Directorate, formerly the Structure Laboratory, NASA Langley Research Center, Hampton, VA; and the Aviation Applied Technology Directorate, formerly the Applied Technology Laboratory, Fort Eustis, VA.

CERL Offers Toll-Free Number

The U.S. Army Construction Engineering Research Laboratory (CERL) has a toll-free number to assist Army engineers in solving construction, facilities maintenance and other engineering problems over the phone.

Dialing 800-USA-CERL outside Illinois or 800-252-7122 in Illinois puts engineers in the field in direct contact with the CERL research staff. CERL researchers can be reached between 8 a.m. and 4:30 p.m., Central Standard Time.

CERL's expertise includes corrosion prevention; paintings and coatings; heating, ventilating and air conditioning controls; alternate energy sources; energy savings techniques; use of microcomputers for managing Directorate of Engineering and Housing activities; more effective space utilization; waste management; pollution control; and environmental planning.

Conferences & Symposia. . .

ETDL Announces Power Sources Symposium

The 32nd International Power Sources Symposium, sponsored by the Army Electronics R&D Command, Electronics Technology and Devices Laboratory, other DOD agencies, the National Aeronautics and Space Administration and the Department of Energy, will be held June 8-12, 1986 in Cherry Hill, NJ.

Two renowned investigators engaged in battery R&D are being invited as guest lecturers to the symposium. Professor Y. Matsuda, Yamaguchi University, will deliver a lecture on rechargeable lithium batteries, including recent progress in Japan, while Professor E. Peled, Tel-Aviv University, will discuss non-rechargeable lithium batteries including recent progress in Europe and Israel.

Technical sessions will be held on rechargeable and nonrechargeable batteries (lithium and non-lithium types), thermoelectric devices, and fuel cells. Scientific and engineering papers describing recent and new developments and advances in these fields are being solicited. Emphasis is sought on NATO and allied military investigations of batteries and other power sources.

Authors who wish to present papers at the technical sessions should submit 150-word abstracts to the appropriate session chairman by October 1985. Authors will be required to get necessary clearances for their papers.

An Advanced Planning Briefing for Industry (APBI) will also be held on June 12, 1986 in conjunction with the Power Sources Symposium. The purpose of the APBI is to inform the battery and power sources industries of future R&D activities planned by the Power Sources Division, Electronics Technology & Devices Laboratory, to identify roles for industry in these activities, and give industry representatives a part in the planning process.

Additional information on the Power Sources Symposium may be obtained from John Murphy on AUTOVON 995-2797/2662 or commercial (201) 544-2797/2662.

Personnel Actions. . .

Wall Receives Third Star, New Command

LTG John F. Wall recently received the third star for his new rank of lieutenant general. He was promoted by Army Chief of Staff GEN John A. Wickham Jr., in a Pentagon ceremony.

Formerly the director of civil works for the U.S. Army Corps of Engineers, Wall also assumed the new position of commander, U.S. Army Strategic Defense Command. The command consists of the same elements which were previously designated as the Army's Ballistic Missile Defense Organization. Those elements are the Arlington, VA, headquarters; the Advanced Technology Center and the Systems Command, Huntsville, AL, (where the majority of the more than 900 personnel are located); and the Kwajalein Missile Range in the Marshall Islands of the Pacific.

The Army program which Wall now directs is a key part of the U.S. Strategic Defense Initiative (SDI). The SDI research effort was launched by President Reagan in March 1983, to provide sound technical options for future decisions regarding development of an effective defense against strategic nuclear missiles.

Prior to his assignment as director of Civil Works, Wall served as commander and division engineer of the Corp's South Atlantic Division in Atlanta, GA. He also served as commander of the Corp's Near East Project Office in Tel Aviv, Israel, with responsibility for constructing two Israeli Air Bases to help meet the U.S. commitment under the Camp David Accord, and as research associate with the "Plowshare Program," Lawrence Radiation Laboratory, Livermore, CA.

Wall has held responsible command and staff assignments both in the United States and overseas including duties as district engineer, Fort Worth District, Southwestern Division; commander, 2nd Engineer Group, Republic of Korea; and commander, 541st Engineer Company (Float Bridge), Germany.

A 1956 graduate of the U.S. Military Academy at West Point, Wall received a master of science degree in civil engineering from Princeton University and a Ph.D. in civil and environmental engineering from Cornell University. He has also received a law degree from the National Law Center at The George Washington University, and is a graduate of the Army Command and General Staff College and the Army War College.

In addition to being an Army aviator and qualified parachutist, Wall is a registered professional engineer in Texas and Louisiana and is a land surveyor in Louisiana.

Among his military awards are the Distinguished Service Medal, Defense Superior Service Medal, Legion of Merit, Bronze Star Medal with V-Device, Meritorious Service Medal, Army Commendation Medal, Air Medal (three awards), Meritorious Unit Citation and various foreign awards.

Beltson Named New ARDC Commander

BG Richard D. Beltson, the former director of the Combat Developments Directorate, Field Artillery School, Fort Sill, OK, recently assumed command of the U.S. Army Armament Research and Development Center (ARDC). As commander of ARDC, Beltson will also serve as deputy commanding general of armament of the U.S. Army Armament, Munitions and Chemical Command, Rock Island, IL.

Beltson succeeds BG Robert W. Pointer Jr., who retired from the Army after more than 27 years of service.

A native of Bronxville, Beltson attended Lehigh University where he earned a bachelor of science degree in business administration. He later earned a master of business administration degree from the University of Kansas.

In addition to his civilian education, the new ARDC commander has attended the Air Defense and Field Artillery Basic Courses, the Infantry Advanced Course, the U.S. Army Command and General Staff College, and the U.S. Army War College.

From 1974 to 1977, Beltson served as executive officer of the 2nd Battalion, 18th Field Artillery (8-inch) and battalion commander of the 1st Battalion, 17th Field Artillery (155mm) at Fort Sill.

His staff assignments have included chief of the Field Artillery Committee, Infantry School, Fort Benning, GA, and staff officer in the Requirements Directorate, Office of the Deputy Chief of Staff for Operations and Plans, Department of the Army.

After the Army War College, he was assigned to the Combined Arms Combat Developments Activity in the Force Design Directorate, and later as director of the Materiel Integration Directorate, Fort Leavenworth, KS.

Beltson's decorations include the Legion of Merit, the Bronze Star Medal with V Device and Oak Leaf Cluster (OLC), the Meritorious Service Medal with three OLCs, the Air Medal with V Device and 17 OLCs, and the Army Commendation Medal.

Ward Receives DMCS


Dr. F. P. Ward

Dr. F. Prescott Ward, a supervisory biological scientist at the Army Chemical Research and Development Center (CRDC), Aberdeen Proving Ground, MD, has been awarded the Army Decoration for Meritorious Civilian Service.

BG James R. Klugh, CRDC's commander, presented the award to Ward earlier this year during a ceremony at CRDC headquarters in the Edgewood area of APG. The Decoration for Meritorious Civilian Service is the second highest civilian honor granted by the Secretary of the Army for outstanding accomplishments.

Ward serves as chief of the Biotechnology Division in CRDC's Research Directorate. He was cited for his leadership, planning, implementation, and contributions to a new biotechnology research program at CRDC. Biotechnology is the exploitation of living cells for useful products.

Ward's research in biotechnology was in progress two years before the undersecretary of the Army designated biotechnology as one of the Army's five major technology thrusts of the 1980s.

He is a graduate of the Pennsylvania State University's preveterinary curriculum and School of Veterinary Medicine. In 1979, he was awarded a doctoral degree in pathobiology by the Johns Hopkins University. His professional affiliations include Sigma XI, the American Genetics Association, and the American Ornithologists Union.

Executive's Corner. . .

AMC Deputy CG for RD&A LTG Robert L. Moore Discusses . . .

The Acquisition Process

Since he assumed command of the Army Materiel Command last year, General Thompson has instituted major changes in several areas of the materiel acquisition process . His major concerns have been:

- Streamlining the acquisition process.
- Finding technologies that will make a difference in an end-strength constrained Army.
- Smart business approaches to acquisition.
- Downsizing equipment for improved transportability.
- Unit fielding as opposed to system fielding.
- Increased and early emphasis on the man-machine interface.

Army Materiel Command efforts in these areas have been (and will be) discussed in detail in feature articles in this magazine. The purpose now is to provide a progress report on the first two "bullets" — the most far reaching and ambitious of General Thompson's concerns. To address them we have embarked on a crusade to change the way we do business. We are looking at every facet of our operations and making dramatic changes to shorten and improve the acquisition process.

Tailored Development Cycle

The most important of our initiatives in weapons system management is our streamlining of the development cycle. In the past, the usual measure of development time was from the beginning of advanced development to initial operational capability. Our new development process changes that. AMCs tailored process eliminates the demonstration/validation phase and milestone II from the process and restructured the other two R&D phases so that a development program will go straight from a proof-of-principle phase (using 6.3 funds) into a development and production prove-out phase (using 6.4 and procurement funds). Essential elements of the demonstration/validation phase will be accomplished in the tech base and proof-of-principle phases.

We are placing special focus on a four-year goal starting at milestone I, the entry into systems development, and ending when we begin production. We have used initial production and not IOC as a critical milestone in order to place emphasis on design and transition to production. We believe that if we do those two jobs correctly, then IOC will come along without any trouble and we will field a quality, timely, cost effective product to the soldier.

But, to do this, many things must be done correctly early in the process. Clearly, the tailored development cycle will never be a reality unless we all pitch in and make it happen. Let me just describe some of the changes we have implemented to help make this happen. These changes are not brand new ideas — elements of them can be found in the management of many past successful programs — but those programs were the exception not the rule.

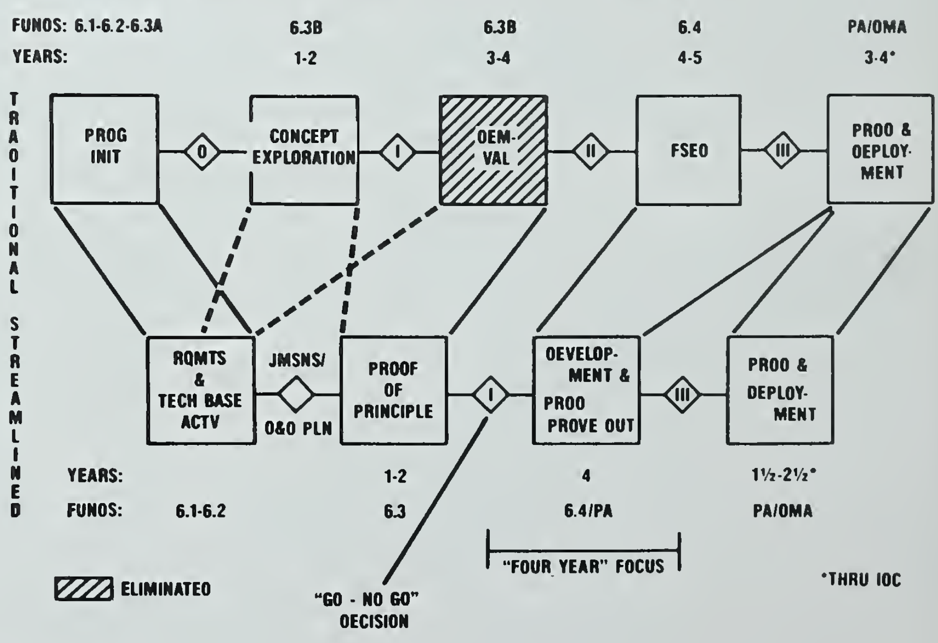
Mission Area Approach

The start of it all is a good plan. The plan I'm referring to is the Mission Area Materiel Plan which is a plan within each mission area — close combat, air defense, fire support, combat support, etc.— that defines where we are today and where we would like to be when we bring on the next generation of materiel systems. The plan does this by identifying all ongoing and projected materiel system developments and improvements and the battlefield deficiencies that are reduced or eliminated by those programs in order to provide a crosswalk between our modernization efforts and our battlefield deficiencies.

The Army Training and Doctrine Command has formulated its mission area analysis for each of its schools and combined these into its battlefield development plan. TRADOC has used its conceptual Army 21 and AirLand battle doctrine to stimulate thought as to its mission area needs.

We are now using these mission area analyses along with their delineated deficiencies to define the necessary research, development, and engineering required for the product improvement of our existing systems and for our next generation of systems. This will allow us to determine the priority of not only our developmental needs but also our technology base needs. We can establish the priority of these needs so that we can mature a particular technology and get it ready to be integrated as a product im-

ACQUISITION PROCESS COMPARISON



provement or as a component of a future system. In this way we also create an institutional focus so absolutely necessary to keep our in-house labs and industry working in the important technologies. We have to re-energize our tech base to insure we maintain our technological edge.

Laboratory Realignment

We believe we have become too bureaucratic in our laboratories and are not doing as well as we should at managing technology by monitoring the research efforts of industry, our allies, our sister services and our in-house labs to insure all contribute and that all are doing complementary, not competitive, work. Money for research is not plentiful and we must use it wisely. We'll not have sufficient money to do all we would like, so we must carefully plan its use.

We have reorganized our laboratories and major subordinate command R&D centers to improve our technology integration. First, we have created the U.S. Army Laboratory Command to guide our laboratory structure in looking at basic research, understanding clearly the threat as projected and insuring we are looking at ways to "leap ahead" of that threat, not just playing catch up. LABCOM has been formed by joining the original "corporate labs" with four other labs whose technologies are widely used across the commodity commands. In turn, the R&D centers of the commodity commands have been upgraded to research, development and engineering centers which will provide a full spectrum of engineering support for their respective commodity commands.

New Technology

The main purpose of the Laboratory Command, with its corporate laboratories, is to bring on new technologies that have a broad application across the mission areas or that have a high payoff and are possibly high risk. These technologies will then be "handed off" to the research, development, and engineering centers of our commodity commands or a project office and integrated into weapon systems concepts or applied as product improvements.

Our commodity commands will bring on the fielded systems. They will manage the engineering development, production, and logistic support functions . They will work with TRADOC to define mission area needs, and they will be assisted by the corporate labs. Our mission area management plans will pull together all the technologies needed to field new systems and drive stakes in the ground as to when these technologies must be inserted into weapon concepts.

Technology Demonstrations

The transition from technology development (6.2, 6.3) to system development (6.4), when possible, will be accomplished by demonstrating the technology in the hands of troops prior to entering development. We expect the bulk of these demonstrations will be done at the Army Development and Employment Agency (9th Infantry Division) or at Fort Hood. Our objective is to demonstrate that the technologies used in a weapon system are mature enough to enter development. To demonstrate the technology we will place a brassboard prototype system in the hands of user troops and have them use the system in accordance with a limited operational and organizational concept developed by TRADOC. In this way we can gain insight into the maturity of the technology as well as the operational concept. In addition, we can gain a better appreciation of the man-machine interface requirements, the impact on command and control, soldier acceptability and hardware performance. The demonstration process should end in proof of principle, completion of a ROC, acceptance of the concept, and commitment of the Army to the system.

If the demonstration is successful and the technology is proven sufficiently mature, we will transition from technology development to system development. We will reduce risk by bringing to development only the mature components and preplan product improvements for follow-on insertion of those technologies that were not sufficiently mature. This means that in so far as possible, engineering development would consist primarily of systems integration, integrated logistics support, and production preparedness. Those programs requiring more research will remain in the labs or in independent R&D — or will be terminated.

Development and Production Prove-out

Given that the technology is mature and the demonstration is satisfactory, we should then move into development. However, we should only proceed with development if we have a total Army commitment to the need, the requirement, the acquisition strategy necessary to execute the plan, and the test plan necessary to judge the worthiness of the system. This is because no project will succeed unless and until the Army is totally committed. Once commitment is achieved, everyone should challenge the need for changes and strive for program stability in order to move the program rapidly toward production.

The major issues to face during this phase are:

- Fully fund the development complete with risk money — no half-way measures.
- Fund not only the development and design of the end item, but also the design and proof testing of the production process and tooling.
- Smooth the transition to production by accomplishing the transition during the development phase (production prove-out).
- Fund adequate testing.
- Final development tests and operational tests should be accomplished utilizing production prototypes, and the technical data package should be sufficiently detailed and complete to allow for competition or breakout if the acquisition strategy calls for same.

Integrated logistics support is a major concern and must provide for:

- Trainers and training materiel prior to fielding the item.
- Initial spare and repair parts structured as part of the production contract.
- Cost realism of spare and repair parts — known and documented up front.
- Components, spares and repair parts require burn in and testing to the same level as the production item.
- Sufficient spares and repair parts need to be procured to support and sustain the end item. Don't skimp.

Testing must also be well planned and executed — don't duplicate. We must build on new data, share data with the entire community, work together to analyze and fix, and we must not take previous failures into the next test. Finally, we must do as much test-find-fix in contractor and development tests as possible. Operational testing should not be a problem. We should have planned for that and executed for success.

Additionally, first article testing cannot be waived nor can the test requirements be downgraded. The bottom line is to do it right up front, take the time to do it right, and fully fund the program.

Any errors or issues should be resolved with complete root cause analyses. Don't correct engineering wounds with band-aids, be professional.

Summary

We have tailored the development process, established a four-year development goal and are making institutional changes to further that goal. But we must keep in mind that the goal is not written in stone.

We must not allow ourselves to be schedule-driven. We will field only when we are truly ready. Reliability, support, and quality all must be there. The performance envelope must be fully defined and met. Training must be accomplished, and the maintenance concept

(Continued on Page 22.)

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